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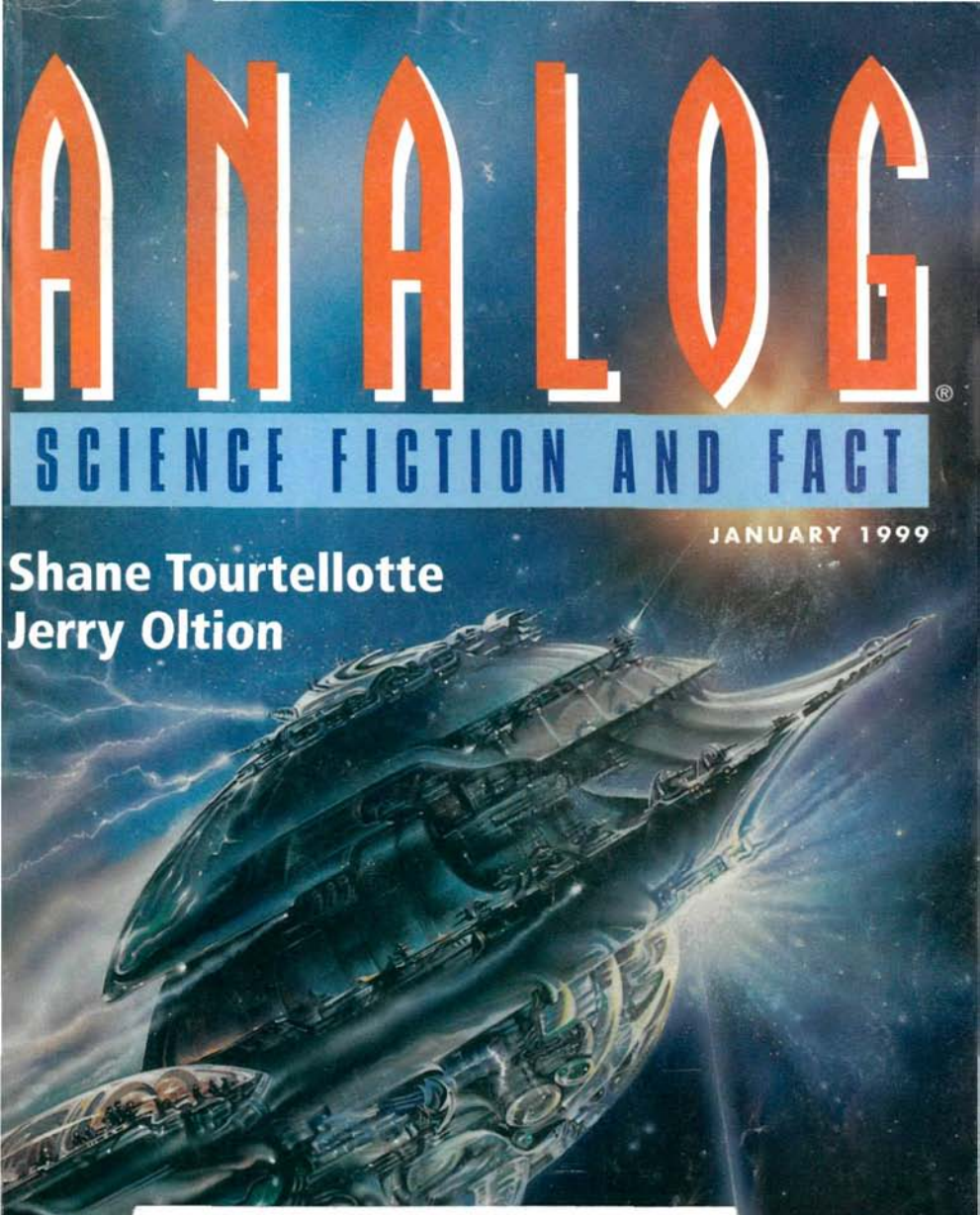

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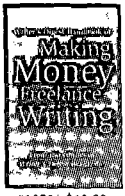

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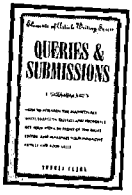

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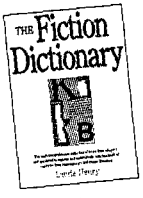

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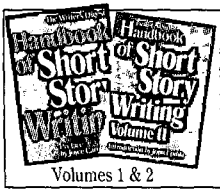

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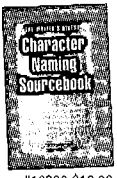

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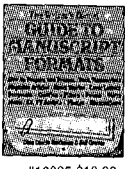

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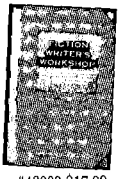

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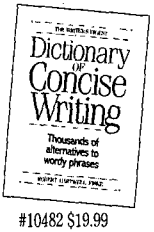

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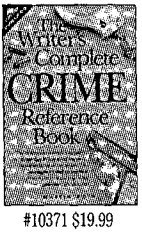

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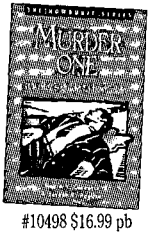

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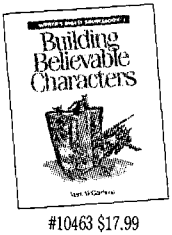

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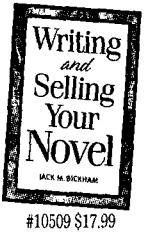

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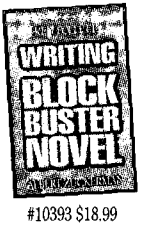

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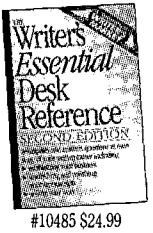

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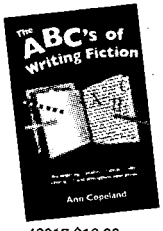

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Vol. CXX No. 1
January 1999

Next Issue on Sale
December 22, 1998

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EDITORIAL Stanley Schmidt

HASTE MAKES HASTE

It's a familiar concept in electronics—so familiar that everybody, not just engineers, has experienced it. It would be hard to find a person who hasn't heard a public address system produce nerve-wracking squeals or howls when the person at the microphone began to speak. Most of us even know the phenomenon by the name "feedback," though we may not know exactly why it's called that or how it works.

It's actually pretty simple. Feedback simply means that the output of some system, such as an audio amplifier, is fed back to the input so that it becomes part of the input. To take a very simple example, suppose you're feeding a simple 400-hertz sine-wave into an amplifier that produces an output with the same waveform as its input, but ten times the amplitude. This is useful, for example, if you're trying to let everyone in a large room hear the output of a low-power signal generator.

Now suppose you take part of the output signal—say, a tenth—and feed it back so that you add it to the input signal (which is still a 400-hertz sine-wave). Your actual input is now twice what it started out as, and if the amplifier multiplies that by ten, your output becomes twenty times the original input. Feed back a tenth of that and add it to the already doubled input, and you now have a quadrupled input being multiplied by ten. . . .

Each cycle of feedback increases the output more and more, and it doesn't take many cycles before the loudspeakers are howling at the maximum level the system can produce. In the familiar practical situation, of course, the input is not a simple sine-wave; and the feedback happens not through a direct electrical connection, but because a microphone is too close to a speaker. But the waveforms of speech stay close enough to the same long enough for several cycles of feedback to occur, quickly building up the familiar and highly unpleasant howl.

Feedback is not necessarily bad; engineers find many useful applications for it. In my own thesis research, using the Mössbauer effect, I had to repeatedly cycle a moving sample through a range of very small, very precisely known velocities. The key to doing so was negative feedback: a sensor generated a signal proportional to the actual velocity, which was fed back and electronically *subtracted* from a signal proportional to what the velocity was supposed to be. The driving force was determined by the difference between what was and what should have been. If they were equal, no force was applied; if there was a little discrepancy, a little force was applied; if there was a big discrepancy, a big force was applied.

The problem in the Howling PA Effect is not that feedback happens per se, but that the feedback is *positive*. The amplifier is supposed to multiply the input signal by a certain amount, but if you keep feeding part of the amplified signal back to augment the input, the output quickly grows to excessive and undesirable levels. To put it bluntly, things get out of control, and what started out as something useful becomes a torture.

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Like many physical principles and effects, this one has cultural analogs. A catastrophe like the Holocaust can happen because a charismatic demagogue feeds destructive ideas to a population that accepts and reiterates them, amplifying them from the beliefs of one person to the beliefs of thousands. The support of those thousands reinforces the original signal, encouraging the demagogue to spread his message still more aggressively, winning still more converts, who give him still more support. . . .

Some tyrants are more subtle, but nonetheless encouraged by positive feedback—like the one in my title. No, it's not a typo. We've all heard "haste makes waste," but it seems to be just as true that haste makes still more haste, which makes still more haste. . . .

And pretty soon things are out of control and haste has become a goal in itself, driving people into an ever-increasing spiral of trying to do everything as fast as possible, whether it needs to be done that fast or not. The result is what I call "the ironic epidemic": a world full of people with more labor-saving devices than anyone before them, working longer hours than their parents, constantly complaining of stress, and forgetting how to relax. The latest manifestation to come to my attention was a Gannett newspaper with the subhead "Technology keeps more Americans wired to the office—even vacationers." The gist of it was that beepers, cell phones, faxes, modems, and other such devices have made it so easy for people to keep connected to their offices that they seldom, if ever, disconnect.

At first glance the problem appears to be, as the subhead on that article suggests, one of technology getting out of hand. I've actually heard people describe it in such terms as "technology has let us down," as if technology were some heavy-handed tyrant that forced us to use it (and be used by it) in certain ways. But that view misplaces the blame, and hides the possibility of a remedy.

The truth is that we do it to ourselves—and we, and only we, can stop it.

Oh, it's not each of us personally, though it is partly that. Not everyone who feels compelled to call the office or spend an hour online doing business every day of "vacation" does so because of a deep conviction that that's the best way to live. Many do it because their employers demand it and they feel they can't afford to refuse. Others do it for fear that if they don't, somebody else will, and thereby zoom past them on the corporate ladder. There's some truth, regrettably, in these views; some employers do feel perfectly justified in demanding far more work than they're paying for, and some employees will do whatever it takes to outcompete their colleagues.

And then there's the fact that some people become so hooked on new technologies that they insist on using their full

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Editorial and Advertising: Analog Science Fiction and Fact, 475 Park Avenue South, New York, NY 10016
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capabilities whether they're needed or not—and, worse, demanding that those they deal with do so, too. E-mail (when it's working) is so easy that the volume of it now sent far exceeds the volume of correspondence when sending a letter required folding a piece of paper, stuffing it into an envelope, stamping it, and taking it to a mailbox. The speed and convenience of e-mail is a real blessing when complex matters need to be discussed and resolved quickly.

But since it can be sent and answered very quickly, too many people now use it to send messages that aren't really worth sending, and expect everyone to answer immediately, whether there's any actual reason for haste or not. (One result, ironically, can be extra long delays in response. A while back I went through a spell of having a lot of trouble getting outgoing e-mail messages to go anywhere, and people took it so much for granted that I would reply instantly by e-mail that they didn't supply any other kind of address. So before changing providers, I acquired quite a backlog of messages that I couldn't answer because I had only an e-mail address and an unreliable e-mail system. Moral: It's a really good idea to include a snail-mail address even when using e-mail!)

That kind of delay, of course, is a bit unusual. The more usual result of the recently exploded prevalence of e-mail is that many of us are receiving unprecedented quantities of written communication and feeling pressured to answer it all Right This Minute. Which contributes to lots of other people having even more of the same problem. . . .

Positive feedback does it again.

Is there a way out—a way to get the advantages of ever faster and easier communication without becoming enslaved by it? Of course there is, but the responsibility for making it happen rests squarely with human beings. The gadgets are just tools; it's up to us to decide when and how to use them, and what demands we are willing to let other human beings make on us because they're available. The technology, in and of itself, does not force us to use it for everything it can do. We need to learn to ask ourselves, "Is this job really worth doing?" and "Is this tool the best one for the job?" and "Does this really have to be done right now, or can it wait?"

Employer pressures are not quite so simple, of course. If employers are making unreasonable demands and most employees go meekly along with them, a lone individual who sees the insanity of

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the accelerating spiral may have to go along or lose his job. But if lots of employees refuse to go along, it gets much harder for employers to sustain their demands. Such considerations are why unions were invented—and employers who shudder at the excesses of which unions have sometimes been guilty would do well to remember that.

In time, I suspect, reaction to current excesses, stresses, and strains will lead to some kind of moderation and a new set of Lines Not To Be Crossed. Vacations—real vacations, not "on-call" vacations—serve a battery-charging function that benefits the only thing some employers understand: the Bottom Line. Employees simply work better if they periodically get completely away from the work. And the Bottom Line is not the only thing that matters. Ultimately people don't live to work; they work to live. And you won't have to look far to find a psychologist to tell you that life has to have more in it than work. But when technology makes continuous, intense work so feasible, people—both employers and employed—are going to have to learn when and how to say no.

Actually, this problem has occurred and been dealt with before, and I don't mean just recently. There's a very old concept in some religions called the Sabbath: one day every week when virtually all work halts and people are free to concentrate, singly or collectively, on other aspects of life. In our present culture at large, this concept has largely been lost. These days Sundays and holidays are seen by many as times for big commercial promotions. There is essentially no time when practically everyone is free to go off alone, or gather with friends and relatives, to do "non-work" things.

This is not entirely a bad thing. When everybody has the same day off, many places get unpleasantly crowded on that day. And some religions' Sabbath observances were less matters of freedom to recreate than rigidly enforced ritual. But there was an important, beneficial idea at the heart of the Sabbath, whether religiously or secularly motivated, that has largely been lost. It may be an idea whose time has come—again.

The key to getting it back, I think, will be the growing, deep-seated understanding that we do not always have to do something just because a technology makes it possible. What we need to learn was very well put by *Analog* reader Gwen Ross: "Intelligence sees how to. Wisdom sees when to."■

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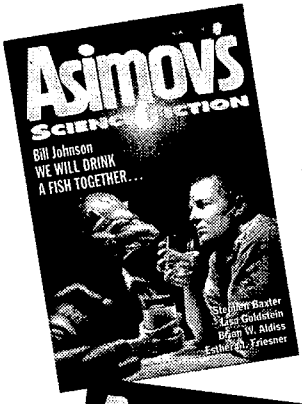

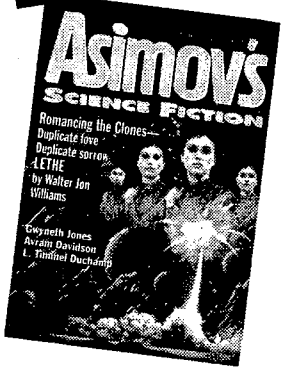

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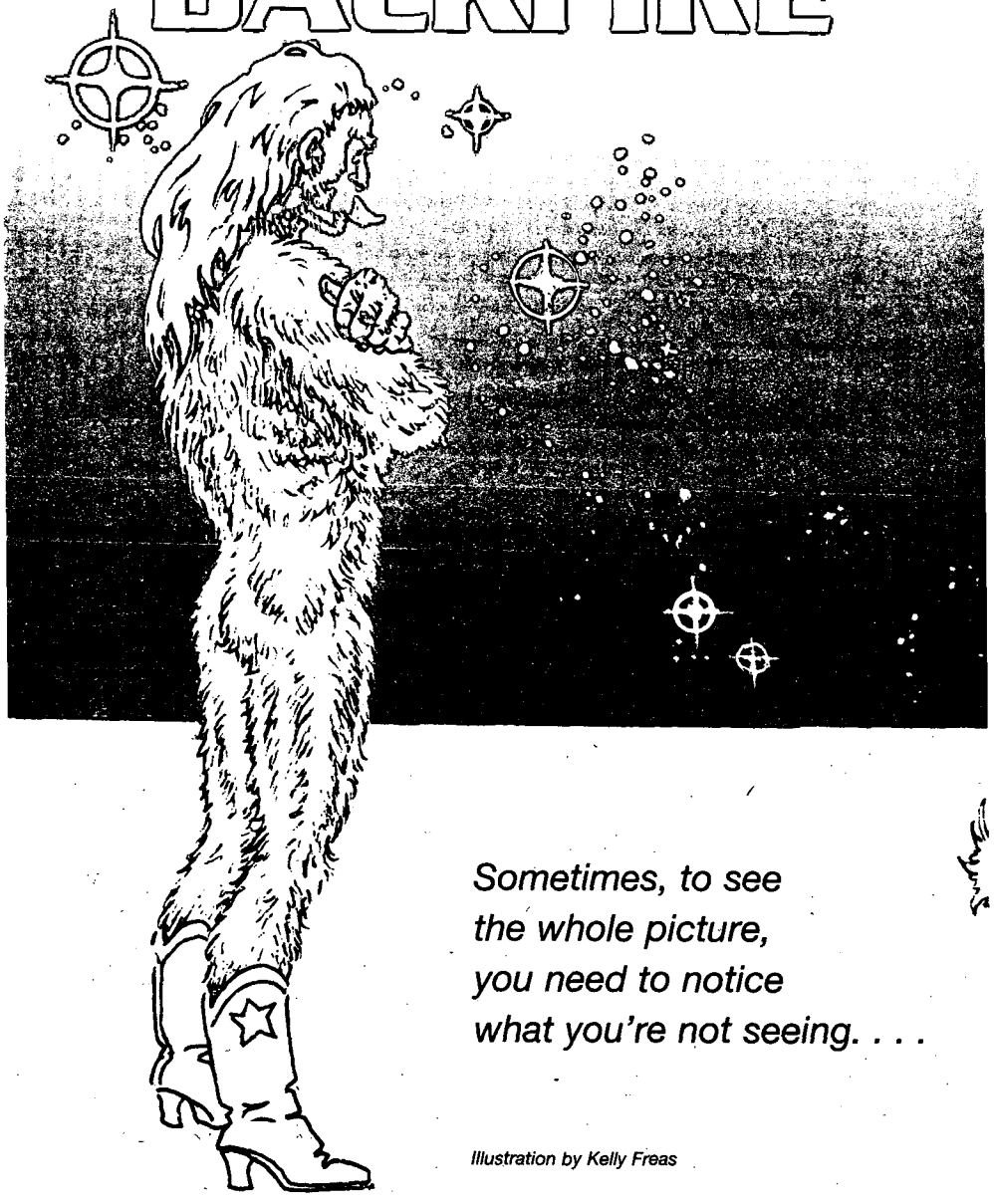
BACKFIRE



Sometimes, to see
the whole picture,
you need to notice
what you're not seeing. . . .

Illustration by Kelly Freas

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The starship freighter *Yankee Shadow* dropped out of intraspace without dying in a sun, or crashing into asteroids. Lord Rokhmyr, "Rokey," first mate and co-pilot, settled into his dash controls to find out just how much trouble they were in now. Perhaps he could find out where they were before Captain Harris woke up and finished his shower. The Captain had not been in a good mood of late.

A light on the dash nagged at the corner of Rokey's vision. He sat up straighter, trying to focus on the array of symbols. Everything was green, including the bank of shield circuits he had not yet repaired. With a sweep of his hand, he absently brushed down the sudden flare of mane along his neck and shoulders. One light was green when it should have been blinking steadily in yellow. The light was saying that everything was right but Rokey knew that was wrong. He began anxiously asking questions of the damage control systems, hoping he could avoid having to park somewhere and go over everything by hand.

Captain Ray Harris came in and announced he had pinpointed the problem exactly. "We're out of water." Enough had been left in the pipes to start his shower, but only enough to get his hair wet. It was plastered down in golden streaks across his forehead. He stood glaring at Rokey with a hurt, angry expression in his dark green eyes as though a joke had been played on him. "How in blazes did we empty the tanks?"

"I've just been trying to find out," Rokey improvised. "Damage control systems are down."

Ray slid himself into his seat to ask his own questions of the computers. He got the same answers. He raked his wet hair back with his fingers, leaving it slick and flat, making him look like a golden, green-eyed skull.

"This could be a problem," Rokey said.

"The air is going to get damned dry if we have to wait for the automatics to reassemble enough H-two-O to fill our tanks."

Dehydration was more of an issue to the Wozurn than to his Terran captain. Rokey's native world was a moist place, where fog was a way of life and smell more important than sight. His race had kept their coat of fur as more than just a fashion statement.

"Your lungs are gonna hurt," Ray said quietly, giving Rokey that guilty look.

"I'll take something for it," Rokey said. "Sickbay can handle that."

"There are a dozen planets around this little sun here," Ray said, gesturing to the closest bright star in their field of view. "One of them will have water of one kind or other."

Rokey nodded. "You get some sleep, Ray. I'll start looking at what's out there."

Ray agreed, but he was shaking his head as he went out.

The *Yankee Shadow*'s sickbay had a good automated hospital unit, high-priced, high-tech and personally enhanced. Its biocomp had everything but a bedside manner, with years of fine tuning to Ray and Rokey's biospecifics. Rokey did get chemical protection for his lungs, but it protected so effectively that he could not smell *anything*. He could not even sense himself breathing, which left him feeling blinded. He could see perfectly well, yet he stumbled at every threshold and had the persistent impression that everything around him was now far away.

Decelerating from half-light speed to orbit the single close-by water world took several days. It was an E-world, blue with oceans, apparently locked in a fearsome ice age. Glaciers spread outward from both poles. Nothing was broadcasting on any frequency except the prodigious buzz of the planet's magnetic field. Every test they ran showed a world too good to be real—rich in oxy-

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gen, drenched with water, and with nothing obvious that their immunized, stellarized systems could not handle. Even if this world did have a sentient race, it was primitive enough that a starship could slip in, fill her water tanks, and vanish unnoticed. Both men were thirsty. Ray's throat and lungs burned from dryness, although he refused to admit that to Rokey.

The computers said they could breathe without masks, and the air was wet. Rokey went outside without waiting. Ray lingered long enough to grab his gun and a jacket. It was chilly outside despite the bright sun.

Rokey sat down at the top of the ramp and let his feet dangle over the edge. "I just need to sit and breathe until my sense of smell comes back," he said to Ray.

Ray stood behind Rokey and slowly pulled on his gloves, studying the landscape. He said nothing, tensely surveying the shoreline of the little lake they had landed beside, and the grassland rolling off to the horizon. Ray did not like planets. They were unpredictable places, full of treacherous, weighty dangers. A planet had too many *places*.

The first bright sun of morning was warm on Rokey's fur, although the equatorial zone of this glaciated world was barely temperate. The breeze off the rose-tinted lake was laden with moisture. Breathing was a delight to Rokey. Moisture burned in his face, making his eyes water. The sky was close and very big. A green carpet of grass covered the slopes down to the water and all the way out to the sky. They had found a perfect picnic-morning place, bright with sunshine and as quiet as the first day of the world, and they *were* the first men to see this. Rokey sat lost in gentle contemplation, warming in the sun.

"They never look this big," Ray said. "Planets, I mean," he added uneasily as Rokey turned to look up at him in surprise. "When they're out there in space, just hanging in front of you, they don't look this big." Ray shoved his gloved hands into his jacket pockets, embarrassed but needing to speak. "I can never understand that. A planet's big, but never as big as they look when I stand on one. The sky isn't under me anymore—it's everywhere. From space I can see the whole sky, but when I'm inside the sky, it's bigger than space ever is. The sky is all I can see, horizon to horizon, like space doesn't exist."

"It's all in your perspective," Rokey told him. "You have a damned peculiar way of seeing things."

"Thanks."

Rokey wondered what Ray meant, but Ray was not paying attention. He turned up the collar of his black jacket, and went back to staring at the horizon.

From one breath to the next, Rokey's sense of smell cleared. He was suddenly aware of the alien flavor of the air, and each breath brought a dizzying wash of new scents. The grass, the lake water, the floating blossoms, the insect life, all emerged into his awareness like color bleeding into a black-and-white scene. Even the sunlight had fragrance. The grass was overwhelming—a rich, complex perfume from a hundred scents mixed, and unlike anything Rokey had ever smelled. Ray bent grass blades under his heel as he walked down to the lake, and the burst of plant oils was a shout of incense on the breeze. It made an enchanting counterpoint to the familiar metal-and-bone smell of the *Yankee Shadow* herself.

Ray interrupted Rokey's contemplation by gently brushing the tip of his ear. He was holding a glass out to him. Ray had used lake water to mix up a batch of Scola, a carbonated electrolyte, the best thirst quencher available. Rokey began to feel better at once.

Ray sat down beside Rokey and showed him a length of green plastic hose, ribbed for flexing. It was the hose to a water bottle. The end was frayed as though lacerated by razors. "Watch your

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toes if you go near the water, old man," Ray said. "The water has teeth."

Rokey was impressed. "Fish did that?"

"A whole lot of little tiny things with too many legs and teeth. I didn't bother to note the species."

"We'll have to add some extra filters to the tank hoses."

"And stand way back when we load—they jump." He showed the heel of his boot, with lines slashed across it like etchings. Ray had good reflexes. They had only gotten his heel.

"Maybe we should wait until dark to fill the tanks then," Rokey said. "If they go to cover or sleep once it's dark, they'll be less of a problem for the hoses."

"Did you get the spin?" Ray asked him. "How long is it until nightfall?"

Rokey thought about it for a few moments, shrugged. "I'm not sure. Ten or twelve hours."

"I'm going to walk around and stretch my legs a little then. It was a long ride here."

"Just remember where we're parked."

Ray grinned and strolled away, hands tucked into his pockets. The burst of the grass's perfume around Ray's boot heels was an explosion of flavors. Rokey closed his eyes and concentrated on identifying the scent-world around. This was a much-enjoyed game of sorting alien smells by a private category—this smell is spiderlike, this plantlike, this purple petal, this one white, and the familiar, clear note of open water singing through them all. The sun warmed his fur, so that he felt a sleepy delight fill him, a pause of wordless appreciation for the simplicity of sun and gravity and wind. Every planet was different, unique, but some things were the same everywhere.

"Hello there, little fellow." Ray's distant voice was clear.

Then he said it again, with a peculiar change of note.

Rokey sat up. Ray was several dozen meters away, stretched out on the grass, reclining on one elbow. There was an animal seated across his hip. It was only as big as a large cat, with an over-sized head and round ears. It was furred a dark midnight blue, with a long tail like a squirrel. They were too far away for details. The little animal was holding Ray's gloved finger its own hands, rubbing its face in Ray's palm.

Rokey gathered from this behavior that the animal was a female. Ray had a natural way with women.

Ray glanced over toward the *Shadow* and saw Rokey watching. Ray sat still while the animal explored his fingers and thumb and wrist. She removed the glove, peeling it back slowly. She sniffed Ray's bare skin, lifting the cuff of his black shirt to nuzzle his wrist. She butted her head against his palm, clinging with her black fingers. "Hello there, little fellow." She mimicked Ray's voice closely.

Ray laughed gently. "What a pretty thing you are," he said, stroking her head with his thumb.

"What a pretty thing you are," she echoed, pressing her head against his fingers. Her eyes slowly closed and she laughed—echoing the soft chuckle she had just heard Ray laugh.

Rokey tried very hard not to think about the fact that "talking animals" fetch a wickedly high price on the interstellar market, but he could see Ray thinking it. He could see it in the sudden frown that darkened Ray's face as he looked down at the little face turned up to him so trustingly.

"I am not an animal," Ray said to her. He said it clearly, with such solemn tone that alarms began to go off in Rokey's head.

"I am not an animal," she repeated immediately, continuing to caress his fingers.

"Don't do that," Rokey muttered under his breath.

The creature picked up the glove and stuck her own little hand inside, lifting it high so that the glove covered her entire arm. She put her other arm in, waving it

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about and laughing Ray's laugh. She tried both hind feet alternately. As she twisted herself around, she stretched out her long legs. Rokey saw that she had flying-squirrel-type membranes folded between her elbows and knees. Her legs were long. Standing upright, she was more than cat-sized. When the glove would not fit her feet either, she put it on her head like a party hat. She then began to remove Ray's other glove.

The glove fell forgotten when she discovered the ring on Ray's finger. She got very serious, sniffing it, turning his hand over to examine it completely. Ray looked up to Rokey as though asking advice.

"Okay," Ray said and let her take the ring from his finger.

"Okay," she echoed. She settled back into the grass to study the silver ring with a very grave attitude. She turned it around in her hands, too absorbed to notice Ray pluck the glove hat off her head and put it back on his hand. The jet stone in the lid of the secret compartment was mirror-polished. She held this up close to her face to peer into the reflection of her own eye peering out. This staring contest went on for a few minutes while she slowly tilted one eye and then the other to peer into the stone. She began exploring the surfaces of the ring with her tongue. She found the hidden latch on the secret compartment quickly, and was much excited by the find. Ray usually kept a tab of gum in that compartment, but it was empty. Enough scent lingered that she sat sniffing it, murmuring, "Okay. Okay."

Ray laughed softly and she opened her eyes, looking up at him. "What a pretty thing you are," she said to him.

Rokey felt a chill that was not from the weather.

She tried to slide the ring onto her wrist, but her hand was too big. She tried with curious persistence. When neither hand would fit, she arched herself about and slipped the ring onto her tail. The ring fit near the base, sliding past the feathery ruff. "What a pretty thing you are," she said to the ring, touching it with tiny fingers. She turned back to Ray, stretching up to pat his face. "Okay." Her voice was still an eerily perfect imitation of his. She studied him up and down for something new to explore, her attention falling upon the laser-gun holstered at his hip. She patted it and deftly undid the catch on the safety strap.

She had the gun half-drawn when Ray finally put out a hand and stopped her. "No," he said firmly.

She patted his hand and tried to pry his fingers from the gun.

"No," Ray repeated, pushing the gun back into the holster and re-strapping it. "No."

"No," she echoed. She reached back, arching her tail so that she could touch the ring, and said, "Okay." She patted Ray's cheek and said, "Hello there, little fellow." She touched the tip of the holster and said, "No. No." The slightly higher pitch of her voice nonetheless carried the intonation with which Ray had spoken. "No okay."

Rokey felt his hackles twitch. "Talking animals" may fetch a wickedly high price on the interstellar market, but messing with the evolution of a sentient pre-stellar race was immoral as well as illegal. He stood up and called, "Ray! Get up here!"

The creature sprang back with a shriek, scrabbling over Ray to fling herself into the air off his hip. Her hind claws grazed him as she jumped, making Ray jump back with a curse. He watched in dismay as she raced away, gliding from hillock to hillock.

"Ray! Get up here!" Rokey repeated more loudly, embarrassed for having caused that reaction.

Ray walked back to the foot of the ramp and leaned against the rail with one hand, rubbing his side with the other. "What was that for?" he said angrily to Rokey.

"I smell blood," Rokey said, striding

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down the ramp. "Did she scratch you?"

Ray pulled up his shirt to show the bright droplets of blood oozing from a double row of scratch marks. "Damn," he muttered, staring down at the red smears on his pale skin. "Now I have to scrub bloodstains out of this shirt, too."

"I thought you wear black because the blood doesn't show," Rokey joked.

"We can discuss my laundry when we have water in the tanks," Ray said, "but I better take this to sickbay for a check."

"You do that," Rokey growled, but it was already too late.

Ray sank down to his knees, clutching the rail. He went limp completely and fell over into the grass. Rokey reacted instantly and scooped him up, carrying him swiftly up the ramp, but Rokey knew it was too late. The wide-eyed look on Ray's face was the surprise of death.

Sickbay biocomp confirmed that the sweet little animal had hind claws loaded with venom. Only Ray's Terran metabolism, alien to hers, had saved him from a more permanent form of death. Ray awoke with a compressed snarl of rage and disgust, curses garbled by the breathing mask.

Rokey had known the return to life would be rough. He braced himself inwardly, a gesture he had learned in response to Raymond Harris. Rokey felt a familiar tug of emotion each time Ray came this close to a final end, an untouchable sadness over the vast difference in their ages and mortality. Ray might live two hundred and fifty years, with luck and breeding. He had both. Barring damage that sickbay could not repair, Rokey would live to be a thousand, and more. He avoided the comparison whenever possible, but he had thought about it while carrying Ray's limp body to sickbay. Rokey waited through the curses, remembering his own sons long ago, when they were young and naked.

"You didn't rip my shirt this time, did you, Rokey?" Ray demanded. "I hate it when my good clothes get ripped up fitting me into this thing."

Rokey peaked his whiskers forward into long white curves, forcing himself not to smile. "That was damn close, Captain. Will you start behaving yourself?"

"I've only got one more good shirt left, Rokey," Ray said in complaint. "Don't you know how to unzip a shirt?"

"I don't get much practice, son," Rokey said, turning away to the biocomp readout so that Ray would not see him smile.

"You would if you unzipped my damn shirt every time you put me into this thing!"

Ray went to his own quarters to sleep, preferring the dark there to sickbay. Rokey knew sleep was best. Watching Ray climb the spiral stair to the upper deck, Rokey sighed, allowing himself at last the wash of emotions he had held away while working to keep Ray alive. He felt a horrified mix of relief and anxiety, with a spark of amazement at the technological magic that had saved him. It was not the first time. Rokey feared it would not be the last, but the wonder of it stirred him. He had lost too many people in his life already. He did not want to lose Ray.

"Grid bless the machine and all who sail in her," Rokey muttered.

Rokey went out as another brilliant, clear dawn was spilling rose-colored light across the lake. He could smell the bright dew on the grass, as well as the warm bodies of the little natives hiding in the cover of the field. The native who had "killed" Ray was close. Rokey had scented the warm honey scent of her fur on Ray while carrying him to the ship. He had paid no attention to it then, but he recognized it and knew it was her. He walked slowly around the ship, checking for damage, all the while wondering if his dense fur was adequate to protect him from her claws.

The *Yankee Shadow* was a beautiful ship. Rokey admired her as he paced

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around her through the waving field. She was a luxury craft, graceful, built for comfort as well as cargo. She had been his home for nearly forty years now. Rokey was used to her.

The problem, when he found it, was a mirror-hard flash of sun reflecting off a cleanly cut hull surface. A great, black hole gaped open, a perfect oval sliced cleanly across the curve of a tailfin.

"We did that," Rokey said aloud.

He knew that section of hull had been covered by the damaged shield circuits. He knew how much he had altered the shape of those fields in order to compensate for damage taken in the exchange of fire as they escaped Van Zandt's orbiting chalet and its Swiss-decor pirates. Rokey had always appreciated the security of intraspace over reality because nothing could touch them in the warps of non-existence between the intertwining dimensions of space/time. Rokey liked that. It reassured him. He was safe because the ship did not exist except inside her magnetic shielding. Intradrive engines drew their power from the ship's presence in the intraspace slip, and they were squirted out safely at their destination because there was no place else to exist.

But it was a very specific, very unforgiving kind of magic. That piece of hull curve was over the water tanks, and it had been *outside* the shielding while they traveled intraspace. It had simply ceased to be. Nothing exists in an intraspace slip outside of the magnetic shielding. The shielding had held the water until the ship dropped into space/time. The exposed tank had simply emptied into the vacuum. Rokey tried to picture their water exploding into space in a sun-dazzle of ice crystals.

"For the loss of a cotter pin," he mourned, "the young men have died."

He went back inside and began gathering supplies from engineering.

Being killed is a disturbing event. Rokey knew Ray needed time to recover. When he awoke, Ray said nothing about the events of the day before. "Time to get those tanks filled and find out what happened to our water."

"I know what happened to our water." Rokey got a hand lamp and took Ray outside to show him the hole in their *Shadow*.

Ray stood staring up in horror at the perfect, shiny oval. "How did they do that to us?" he asked nervously. "No weapon can burn that cleanly through dimonoid."

"We did that," Rokey explained.

Ray responded with a distant, bewildered look.

Rokey explained about having had to alter the shape of the magnetic shielding, exposing that section of hull to intraspace. Both men knew why the tanks were located where they were, so there was nothing to say. Rokey had expected Ray to say it anyway.

Ray stood staring up at the damage. "We can't refill them completely until that's repaired. I guess it will have to wait until morning after all."

"I got a start on it," Rokey said, "while you were sleeping. I got all the sealing circuitry into place. I just have to fit the patch into place and power it up."

"You need more light for that."

"That's why I quit working. I'll finish in the morning."

Ray nodded, turning to go back inside the ship. "I'll get the hoses out and fill the tank just enough for a shower and a decent meal."

"I'll cook," Rokey said. "Mind all those teeth in the lake."

A long hot shower and a long hot meal relaxed Ray a little. His manner was less gruff, and he agreed to a drink with Rokey after dinner. They were stretched out across Rokey's wide bed to watch a movie, when Ray sat up, drink in hand, to regard Rokey with solemn eyes.

"What is it, Captain?"

"I'm sorry I put you through that."

Rokey grinned. "You've done worse,

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son. As long as you're still talking to me, I can take the strain."

Ray poured another round of drinks. They toasted the *Yankee Shadow* and fell asleep watching a film they had both seen a dozen times before.

The next morning when Ray went out, Rokey was just ahead of him. "You have everything you need out here, old man?" Ray squinted up at the impossible damage to his ship.

Rokey held up his tool pouch and the antigrav 'ladder-belt' he had brought.

Ray eyed the antigravity belt unhappily. "Only one of those works, you know," he said. "Are you sure you have the right one?"

Rokey strapped the belt around his waist. "I duct-taped the control panel shut on the bum one right after it dumped me."

"Right after you came to," Ray corrected sharply.

Rokey shrugged and tapped the belt control power-on. The idiot lights blinked fitfully. "See?" Rokey dialed up the zero-g controls, and began drifting upward.

Ray watched, shading his eyes to see against the sky. He stood there watching while Rokey fitted the patch in place, and adjusted the powerful magnetic sealant. It was slow work. After the first hour, Rokey began to feel the lightheaded ache of overlong exposure to an inadequately shielded antigrav field. He was about to dial the unit to ground-return when he heard a voice. "Hello there, little fellow!"

He looked down and saw the dangerous native balanced on Ray's shoulder. She was rubbing her face against his chin, chuckling with his voice. "Okay! Okay!" she chirped.

"Hello again," Ray said to her. He was standing very still, clearly aware of the way she was bracing herself against his back with those deadly claws. His heavy flight jacket seemed suddenly too thin.

"Hello again," she echoed.

Rokey also held still, floating against the curve of the ship. He kept his hands poised over the belt controls, readied for an emergency dive.

The creature stretched her arms around Ray's neck, draping the folds of her furred wings around him in a hug. "What a pretty thing you are," she purred.

She lifted her head and called over her shoulder, a long sentence of barks, yips and growling vowels.

One after another, three little heads with round ears popped up from the grasses.

"Hello."

"Hello."

"Hello."

There were still hints of Ray in their voices, but already the native accent was sounding. The leader barked at them some more. They came leaping up through the long grass, calling in yips and squeals.

The ring-bearer dropped from Ray's shoulder and ran to meet them. She put her hands out to the smaller two, and led them up to Ray.

"Hello there, little fellow," each in turn said to Ray. "I am not an animal."

Ray dropped to one knee and solemnly shook hands with each.

Rokey wondered if four sets of claws would kill Ray four times as fast, or just four times as dead.

Ray stood up with smooth, easy grace, moving away from the little group. Rokey tensed. The natives crowded after Ray, reaching up to touch him with their little black hands and chorusing, "Okay! Okay!" They were all eyes for Ray.

When Ray stood far enough from them, Rokey began drifting downward. His shadow touched them, and they froze, looking up. The leader yipped a command, and they all dashed away, diving into the long grass and disappearing.

"Did they scratch you?" Rokey asked as he landed beside Ray.

Ray said he was all right, but Rokey insisted Ray pull up his shirt so he could

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examine his back and be certain. Ray let him. The natives did not return over the long afternoon. Ray stood below Rokey, patiently keeping guard. Rokey worked carefully despite the time it took. They couldn't afford to do this again. He had come to the conclusion that four sets of poisoned claws could kill Ray four times as fast *and* four times as dead.

When the work was done, and the tanks secure, the two men sat together at the top of the ramp, watching the cherry red globe of the sun sinking into the grass. On the still waters of the lake the flowers were closing with the twilight.

Rokey turned to Ray, sniffing gently. "You got sunburned, Ray," he said.

Ray touched his face with a gloved fingertip, flinching. "So I did."

"I bet that hurts," Rokey said without sympathy.

"I thought planets were for protection," Ray said in protest. "You keep telling me it's safer on a planet."

"Not if you stand out in the sun all day with a naked face."

"How come you don't get burned?"

"I'm not naked," Rokey replied with dignity. "You get your face uncooked in sickbay, and I'll cook us some dinner." They went inside when the stars came out, and Rokey went up the spiral stair to the galley, chuckling.

The intruder-alert system woke them just before dawn. Scopes showed a cluster of the natives gathered on the ramp. They were holding on to each other and pointing up at the starship. Both men laughed. Ray reset the controls so that the intruder-alert would accept the natives as harmless. "We won't get any sleep otherwise," he said to Rokey. Rokey agreed and went back to bed.

Ray stayed to watch them in the screen for a few minutes, but he was more sleepy than curious, and went back to bed himself.

Rokey was waked later in the morning by the intercom. "Why did you let them in here, Rokey?" Ray's words were echoed by little native mimics.

"I didn't let them in!" Rokey protested. "I've been asleep."

"So have I. Damn. That means they let themselves in."

Rokey lay back and stared up at the trideo screen curving over him, seeing in his mind little black fingers deftly mimicking the pushbutton sequence for the airlock controls. Why had he assumed that their talents for seeing things in context were merely verbal?

Ray met him in the galley a few minutes later. He was fully dressed, with boots, jacket, hat and gloves.

"Where's your fan club?" Rokey asked as Ray sat down at the table.

"They discovered the mirrors when I put the lights on," Ray told him. "I decided getting dressed was more productive than hiding under the quilts."

Rokey wished they weren't so afraid of him. "I bet that was a sight. Did they try to get inside the mirror?"

"No. I kind of expected that. They licked the glass, but only once. I think that was to see if it was water." Ray chuckled. "They also did some checking first to make certain nothing with teeth would jump out of it."

"Hilarious if it weren't so disturbing," Rokey observed. "I'll finish sealing in that patch. You figure out how to get them off the ship without anymore fatal contact." He paused, reconsidering. "First I'll see if the biocomp can provide you with some kind of antidote—just in case."

Ray nodded, his face sober. "Just in case."

The biocomp produced a packet of skin patches with antidote doses primed for release if Ray were scratched again. "But watch it, son," Rokey said darkly as he gave the packet to Ray. "The biocomp says this is only stop-gap—you still have to get to sickbay if anything happens. Those little critters are as deadly as they come."

Rokey left Ray seated at the table,

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reading the instructions on the antidote packet, and went out to begin testing the seals on the hull patch. Micro-cracks had appeared in one of the circuits and it had to be replaced. It was slow work. Rokey finished the repair, and the tests on the rest looked good. After a day's exposure to direct sunlight, he would test them again. If the seals were holding, they could leave as soon as he finished the damaged shield circuitry repair.

Rokey found Ray in the galley, acting as ringmaster for a water circus. Several dozen of the natives were frolicking about in wet merriment, splashing with their tails in the water and flinging drops, squealing and sliding in the puddles on the deck. There were cries of "Okay! Okay!" amid barking laughter and chatter.

Everything changed when Rokey was spotted in the entry. There was a shriek and a scattering and screams until Ray yelled, "*Freeze!*"

They all fell still, frozen in loose puppet poses, suddenly a roomful of wet plush toys.

"How'd you do that?" Rokey asked in amazement.

"I played with them. They pick stuff up fast." Ray's face was alight. "I've got them cued to a start word, too, but I don't know how long they'll play if they're scared of you." He grinned at Rokey. "I figured this was one way to protect myself from their claws."

Ray walked up to Rokey, and put out his hand. "Shake hands, mate. That way they'll know you're a friend. I taught them that, too."

Ray looked at the natives. All eyes were on him. "Friend," Ray said clearly, drawing a line in the air with his hand between himself and Rokey. "Friend," he repeated, gesturing around to all of them. "Okay, okay." He nodded sharply. "Action!"

They sat up, each drawing its tail underneath and its glide-skins tight against itself. Their wide dark eyes were now all on Rokey. Some nervously patted down wet fur, stroked dripping ears, squirming uneasily in place. At last the ring-bearer walked over to him, standing tall on her long legs, and put her tiny hand out to him. The drape of her furred glide-skin was like the fold of a royal robe. "Hello there, little fellow," she said, using Ray's voice. "I am not an animal."

"Delighted," Rokey said softly as he shook hands with her. "I am not an animal, either." Rokey could not resist. He had been a teacher for so many years. Her hand was doll-like in his, but her grip was sure. He looked down into her little face, seeing someone looking back at him. Fear and curiosity battled in her dark eyes, but curiosity was winning.

"Delighted," she echoed, trying out Rokey's deeper timbre.

The word chorused around the galley as each tried the Wozurn's different voice.

"I told you to behave yourself, Ray," Rokey protested.

"Not a mark on me." Ray held his hands up. He was wearing gloves and his flight jacket. He tapped his neck to show that the antidote patch was in place.

Rokey could see Ray was pleased. He was relieved Ray had recovered some humor, but he was himself losing temper. There were laws against this kind of interference. He put his whiskers back and glared at Ray. Ray just grinned.

The native seated at the sink splashed her hands in the water and caught Rokey's eye. "Water." she patted the surface of the water in the sink. "Water in sink okay." She pointed down to the deck. "No water on decks. Water on decks no okay."

"Okay-okay," Rokey said approvingly, in his most fatherly tone. The look he gave Ray was closer to the truth of how he felt.

Ray winced.

Now that Rokey was acceptable, Ray was pretty much abandoned by the

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group of invaders. Rokey became their playground and entertainment. He was grateful that the little natives no longer feared him, but he began to feel invaded. He could no longer get any work done. They went about with him everywhere, following his every activity with rapt intensity. Each new tool, circuit piece or container had to be smelled and tasted by his attendants, something he had to be carefully selective in permitting. If he said, "No-okay," they obeyed, but with childlike disappointment. He began to look for things that would distract them.

The monitor screens in engineering did the trick. They crowded around every screen they could reach, squealing and barking in alien conversation laced with happy cries of "Okay-okay!" Rokey called up a series of very basic, very ancient cartoon shows that were an instant hit. He was able to finish realigning the shield circuits in peace. He kept pausing to watch them, entertained himself. They chattered together with great animation over the shifting cartoon imagery, sometimes running back and forth excitedly between screens to continue the conversation with a different companion.

The knowledge of Knowledge marks the boundary between "talking animal" and Native Consciousness. A ghost from Rokey's professional past rose up to touch him with a cold finger of the Heisenberg reality behind every observer. They were here. They had seen. They had been seen.

The urge to attempt some damage control finally overwhelmed him. He turned off the cartoon show. This was met with shocked silence. Someone said, "No! No-okay!" Rokey felt as though he had just taken candy from children, but he shook that off and led them all outside.

Ray followed the parade out to the airlock ramp. "What's wrong, mate?"

"My conscience," Rokey replied. "We should *not* be messing with these people. We came here for water, and this is getting out of hand."

"Yeah," Ray said, looking down at the group gathered around Rokey's knees. Clearly they were waiting for the next game, heads up to the breeze, sniffing in the sunlight. "Just our luck to find them as well, isn't it."

"Ray!" Rokey glared. "These are not talking animals!"

Ray showed surprise. "You damn straight they aren't. That little Jasper there with my ring, I like her. She's a nice lady, and she cares about her family. I care about her family." Ray pointed to the grass ring of the horizon. "Where are the trees, Rokey?"

"What trees?"

"Exactly. I keep thinking about that. Listen, mate." He put a hand on Rokey's shoulder. "You finish up the shield circuits, and I'll keep our little family circus here out of your way so they don't bother you."

Rokey could see something shielded behind Ray's green eyes, and he wondered what was bothering his young captain. "You have the antidote patches?"

Ray nodded.

"Keep your gloves on, son," Rokey growled, "and stay close to the ramp." He went back inside.

The damaged damage control circuit took hours to pull apart and test. Rokey got caught up in the work. It was simple enough, but required patience, the reason he was better at it than Ray. Ray often declared, "I fly starships—I don't fix them, and I don't clean them." Ray could do the work, but only under protest. Rokey let his concern and troubled conscience fuel the job. He wanted off this world and away from the dilemma of those dark eyes wide with curiosity, and those tiny black fingers exploring.

Rokey had the ship's outside security cameras open. From time to time he would glance up to locate Ray's tall, black-clad figure outside in the blue-

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sky sunshine and grassy openness. It was an unusual sight. Ray was not a planet man. He didn't do planet things. Sitting on a lakeshore playing with children just wasn't an image Rokey had previously associated with his volatile young captain. Raymond Harris tangoed in exotic starlanes and chased about with pirates. He didn't play child games. The child had been wrenched out of him by war and conspiracy. Rokey went back to his work with renewed focus. They had to get out of here.

Mid-afternoon he noticed that the crowd of natives had increased in size. Hundreds surrounded Ray at the base of the starship ramp. Some aerial games had begun, and Rokey zoomed in a closer image. Evidently Ray had taught them how to weave a ball of grass blades. They were using this to play catch with all the enthusiastic acrobatics of an Olympic team. They were skilled in glide control, using the furred skin flaps along their bodies and their tufted tails. Ray was grinning happily as he tossed these grass balls around for them, keeping a safe distance from the claws around. The work was finishing up, and Rokey went down to the tail section access to put in the last pieces of repaired lines. They would leave soon.

Early in the evening, Rokey crawled out of the access tube, cramped but feeling at last a sense of release. They could go. He had put all the pieces together again.

The silence on the ship worried him. He had assumed Ray would be onboard by now. He was alarmed to realize that he had let his attention wander from Ray out there with all those poisonous claws. He went up to the bridge to look around for him. The night was ablaze with wild stars, with the broad arm of the Galaxy shining like a white river across the sky.

Rokey put on the security cameras, and was hit by a wave of sound that put his hackles up and sent adrenaloids coursing though him.

Fire.

It was the sound of flames crackling through dry grass, the rush of smoke. Fire alarm swept through him, raising his fur straight up around his face and shoulders and his back. His whiskers went out flat. Rokey made himself slowly and carefully put down his tools.

Fire.

Fear of fire was the deepest, most sophisticated fear Rokey knew, a civilized instinct. Rokey's training in space travel had refined that fear to an ice-cold, logical certainty. There were specific things that had to be done about fire immediately or he would die. Fire was the raw response of the universe to mistakes, to casual action, to carelessness. Rokey went out, bellowing for Ray.

Rokey was met at the opened airlock by a wall of sound and the scent of grass burning. The roar of flames raged like a consuming holocaust, and the sharp bite of burning plant oils choked his breath.

There was, however, only a small campfire at the base of the ramp. Ray was on one knee beside it, feeding in clumps of twisted grass. The natives were gathered close. Rokey realized that the sound was their hundreds of voices imitating the little fire as they had imitated Ray's voice. They were repeating the fire's noise with wild enthusiasm, amplifying it until the cold night rang with fire. The music of the flame was their fireside song, voiced a hundredfold, and they writhed about, dancing like the flames.

Fire-fear, ancient and timeless, melted Rokey's strength. For an instant he felt his reason evaporate. His breath was stopped in his lungs. He gasped for air, and his eyes turned red. He made himself double-check that the airlock was closed and latched, then walked slowly and steadily down the ramp. He had intended to be calm but he arrived at the bottom like a storm into the party. They

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scattered from his path with laughter and shrieks.

"Hey, old man," Ray said as he rose to his feet. He was grinning. "Join the party." The fire blazed beside him and he stood wreathed in smoke, his blond hair shining red-gold in the light. The singing was loud, and feeling was thick in the air.

Rokey tried to catch his breath. "How did you start a fire out in the middle of nowhere??" he demanded angrily.

Ray's grin faded. "You taught me to use a flintrock, old man. You said a starman had to know how to survive on dirt and rocks, remember?"

Rokey felt insult surge into his outrage. He had insisted on teaching his partner the most primal art of his own race, striking fire from the rock. The barbarian is always only a generation away, but Rokey was accustomed to such debate made in a calm academic atmosphere, in remote and reasonable halls of learning. The cold night air crackled with flames and chaotic chanting, and his feelings buzzed and crackled through ancient and modern taboos.

Fire shadows flashed red and black across Ray's hard, narrow face. His eyes seemed to bleed fire, and red light glowed dully on his hands and shoulders. "What's wrong, old man?" he said.

Windblown smoke like acrid anger in a closed room etched pain into Rokey's eyes. "Ray, blast it!" He growled. "Get inside!"

Ray drew up, surprised by Rokey's intensity. Anger turned his fire-shadowed face cold. "I have to show them how to put the fire out properly," he said evenly.

"*Get inside!*" Rokey shouted, reaching out to grab Ray's arm—forgetting utterly with whom he was dealing. Ray did not move. Rokey snarled another command in Wozurn, unable to stop his rage or his confusion. "We're leaving. Now."

"No," Ray said. "Not until I finish here."

"Now, Ray!!"

"Hey, Rokey, don't go all King Kong on me."

Rokey never knew before or after whether he actually struck Ray or merely threatened to. The night erupted abruptly between them in a protective wave of furred bodies. Rokey was pelted by small hard fists. Some even flung themselves bodily against him.

"*Freeze!*" Ray yelled.

Some did, but Rokey's passion and hysteria had sparked a blaze of panic storming around the two men. Ray was at the center of the storm. Blows and claws bounced from Rokey's dense fur, but Ray was at the center, and vulnerable. Ray could feel their hindclaws scrape him as they leaped off him to fling themselves at Rokey. They were trying to protect him. Ray knew he was in trouble. He knew it at once.

Rokey knew it, too. Cold fear for Ray's life damped out his fire-fear panic, but the night boiled around him as tiny, frantic bodies thrust themselves between him and Ray. Rokey could not reach him. They were protecting Ray. They did not know what they were doing to him.

"*Freeze!*" Ray yelled again. His voice was breathless, thin. The panic in the night was complete. Ray pushed them away, stumbling toward Rokey. He had no breath left for words. He fell to his knees at the base of the ramp.

Rokey flung natives aside and gathered Ray up in his arms without breaking stride. Ray was no longer breathing, and Rokey felt no pulse.

The natives screamed on in their innocent protest. Rokey punched open the airlock and went in. Ray's body in his arms was limp, a terrible weight, a dreadful stillness.

Time became a blur of movement. Rokey raced against time and entropy and the laws of reality that said when a man had died he was dead.

Raymond Harris had his theories about Luck. Rokey had to trust to his

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machines. It was not magic which would draw Ray Harris back to life. The manipulation of cellular interfaces was the pride and flower of civilized technology. It was a tenuous promise here, undone by the cold pallor of Ray's face. The hospital unit breathed for him, made his heart beat, pulsed the slow deep pulse of the carrier wave that bathed a living brain. Ray hung suspended in and breathed with the machine, but the computer could not find Ray. Hospital said his brain was alive. He did not respond.

Rokey pushed the machine to its limits. He made demands of it beyond manual specs. The biocomp insisted that Ray was alive. Rokey was afraid to believe a computer readout while Ray hung limp and would not respond. Rokey made the machine clean Ray's blood of poison five times, a dozen times. The shock had gone deeper than tissue and bone. Lost out on the edge of forever, Ray had to *want* to return.

Rokey wanted to be furious with Ray's casual attitude toward the dangerous natives, yet Ray Harris was born and bred in starlanes far from any natural gravity field. What would he know of wild animals? Ray did not have the innate, planet-bound prejudice that any creature with a different anatomy from his own was an "animal." The only non-hominids Ray had ever known were either sentient aliens or star-bred pets already adapted to the cosmopolitan demands of galactic society. "Animals" with deadly poison simply did not pass customs. Ray had nothing in his background to make him wary of claws. Rokey tried to view this all through Ray's peculiar perspective, but quickly gave up. Rokey was too thoroughly educated, too planet-bound in his own point of view. He had known true wild animals, had hunted some, had even loved a few. He was a galactic citizen with a nose as keen as a wolf. He had seen a creature, and classified her the same way he had classified the scents of her world, categorized them, and distanced himself from them as result.

Ray, however, had seen a nice alien person with a friendly personality, and a family she cared about. Rokey had seen a pixel in a pattern. Ray had seen a lady.

Rokey looked down at Ray's strong, fine features smoothed to gentle sweetness by the depth of coma. Yes, Rokey had even loved "animals" in his time. His anger was not at Ray's cosmopolitan-styled innocence. Rokey was just angry. He had to let it go at that. Knowledge was power, but sometimes only patience worked.

The computer would call if there were any change. Rokey could no longer bear the sight of Ray's cold face. He left, going up the stairwell like an old man, head bowed.

Rokey paced the long corridor to his cabin, needing to lie in the cool sweet dark and mourn. He paused before going in, turning on his heel to listen. There was a whisper of sound, steady and insistent, as though there were something outside the ship. Rokey listened as intently as only a civilized hunter with large, swiveling ears could listen. He heard the soft sigh of the ventilators and his own breathing. He could hear his own heartbeat in the silence if he concentrated, but underneath that was a fainter susurration, far away. The noise grew more frantic, a rushing against the hull. Rokey wanted to leave, to take the risk of lifting off to orbit on his own, but he knew that was impossible. The ship's entire computer structure was tied up in the elaborate complexities of keeping Ray alive against the hard, electric pull of death, real death, final death. Rokey dared not strain the balance.

He went up to the bridge.

The noise was a rush of surf, loud and desperate. The bridge was dark, utterly dark. The stars and pre-dawn light were gone. Something outside was covering the ship, burying them.

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"No!" Rokey leaped for the dash, switching all lights on at once.

His first wild impression was that he was buried in eyes, thousands of eyes, huge round eyes piled high around the ship, eyes pressed against the viewshield, wide eyes unblinking, all staring at him.

The complete absurdity of it sobered him sharply. He leaned forward, closer to the curved shield. It was actually the natives' faces pressed against the viewshield, with their wide dark eyes staring at him, following him. The people of this world were watching him, pleading for something. They waited for him to understand, a thousand pairs of eye contact. They were speaking. They were all speaking together, and their gathered voices whispered against the hull of the *Yankee Shadow*.

Rokey switched on the outside security system, and their voices struck with a thunderbolt of sound. They were calling, "*Ray!*" together in a single, huge voice, over and over. "*Ray!*"

Rokey stood for a long time pinned by those eyes and pounded by the hundredfold repetition from those alien throats, by that single syllable repeated, "*Ray*." He snapped off the security camera. The silence fell sharply, but the faint susurration of their voices went on.

Rokey licked his suddenly dry lips and brushed his flared whiskers back with one finger. The aliens each copied his gesture, brushing a tiny finger across a tiny cheek.

"Perfect little mirrors, aren't you," he said. "No. More like little trideo machines with a lifetime supply of film."

The chanting went on. Rokey left.

Ray's call roused Rokey from a fitful doze. He was halfway down the stairwell before fully awake.

"That was my last good shirt, old man," Ray complained when Rokey pulled him free of the mask.

"Where have you been?" Rokey demanded breathlessly. He did not understand the question himself, but seeing Ray risen from that deathlike pallor and stillness was as much a fright as a relief.

"I've been in here losing my shirt!" The blaze in Ray's eyes was real and familiar. "And I'm hungry."

Rokey helped Ray to climb out of the zero-g field. The man's grip in his hand was firm. He looked unscathed. "I'll cook," Rokey said to him. "It's the least I can do."

Rokey paused in the doorway as he went out, turning to meet Ray's eyes.

"I'm all right," Ray said quietly. "Really."

That made Rokey worry. Ray would never have said anything if he really were all right.

Rokey went up to the bridge first and opaqued the view-shield. They were still out there, pressed against the ship, chanting. He did not want Ray to see them. He did not want *them* to see Ray. The sight of the aliens had taken the edge off his pleasure at Ray's return. Feelings swept through him in a storm-wind of confusion, drawing his breath tight. "Sturm und Drang," he muttered bitterly, paraphrasing from the original. "Always the Sturm and the Drang."

"Who rang?" Ray asked as he came in to the galley.

"Sturm and Drang," Rokey repeated more clearly. "It's a Hollywood term. It's how I feel."

Ray sat down quietly to the meal Rokey had prepared. He had showered and changed into a loose terry robe. His tousled hair and angry eyes made him look hungover. They sat in silence while Ray ate. Rokey accompanied him with a drink, then with several more. The "Sturm and Drang" began to fade.

"Go ahead and say it, Rokey," Ray said finally. "You're killing me with kindness."

"You shouldn't have done it, Captain," Rokey said.

"I had to do it."

"Why?"

"Where are the trees, Rokey?" Ray demanded.

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"What trees?"

"Exactly!" Ray said. "No trees—yet they evolved as gliders. What happened to the trees?"

Rokey shrugged. "I don't know."

Ray leaned forward, his voice intense. "The glaciers ground down everything but the grass, old man. Those little fellows are trapped between solid walls of ice, and the better I got to liking them, the more I had to think about that ice closing in on them."

"It's illegal, Ray!" Rokey protested. "It's wrong! It's not fair to them."

"Rokey, this is not some treatise on mythological evolution you're preparing for a class. Those are real, live people out there. That little Jasper, she's a real, live person and I like her. There isn't much left of her world anymore. It's buried in ice. I had to do something."

"You certainly did do something, Ray," Rokey said. "I don't argue with your reasons, just your reasoning. There are anthropological services at Rokherton University set up for threatened worlds like this one. With a proper survey, by experts . . ."

"They take years to do proper surveys," Ray went on. "And decades to make recommendations. Meanwhile my little Jasper is out there dying in the cold!"

Rokey made one final grasp for the proper, established solution. "She's only one individual, Ray."

Ray's green eyes flared, and he slammed his fist on the table, making Rokey jump. "That's *right*, old man! She's an individual, a life, a *person* in there. What the hell is the use of sacrificing real, live people in the name of culture?"

Rokey realized how easily he had come to see Ray as a child because of his naked skin, seeming unfinished and naïve. Ray was not. Ray was a grown man who had lived through as much life as Rokey in a fraction of the time, forced to race through it at breathless, violent speed. Rokey had seen the natives' lives in terms of epochs and evolution, as peoples and nations. Ray saw the few, sweet bitter moments stolen from between the walls of ice. The two sat silent with a gulf of centuries between them.

Ray shook his head, drawing back from the confrontation. "I died for them, Rokey. Twice. I think I've earned the right to be involved. I am involved."

That same ghostly Heisenberg reality chilled Rokey, but he knew it was too late for any solution but Ray's. Rokey resisted, carried by the momentum of two centuries of belief in noninvolvement with pre-stellar cultures. He believed in the reasoning still, but in this place it had become mere theory. The light had struck, and the course of things had changed.

"We're both right, captain," Rokey said. "There's no point in arguing over that part. You're giving them an edge over the ice—and an edge over every other tribe on the planet."

"Maybe. Maybe not."

Rokey sighed. "It's the luck of the draw, I guess."

Ray's green eyes lit with a private delight. "The luck of *whose* draw, old man?" he said. "Was it our luck that brought us here? Or *hers*?"

Raymond Harris had these theories about luck. Rokey had his theories about Heisenberg reality, and the importance of good reflexes. Theories meant nothing against the image of all those eyes pressed against the glass, staring at him. Theories had no weight against that bereaved voice crying Ray's name in the dawn. There was no answer. They were both right.

Rokey sagged back in his seat. "I'm just glad you're back, Ray. The rest we can leave behind us."

"I still have to show them how to put the fire out," Ray said.

"No!" Rokey said firmly. "You are not going out there again."

"I have to show them how to put the fire out," Ray repeated slowly.

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"Ray, they think you died."

Ray looked down at him, not quite grasping Rokey's meaning.

"They saw you die, Ray."

"When I'm as drunk as you are, old man," Ray said, "maybe I'll understand what you're getting at."

Rokey sighed heavily, and reached up to massage his ear tip slowly between his fingers, leaning his head against the palm of his hand. His thinking was still snarled up in the memory of Ray's pale face and limp, dead weight in his arms. "They think you're dead, Ray. You can't go back out there. You can't let them see you at all."

Ray studied Rokey's face for a moment, thinking about this. "So, I'm not dead."

Heat rose into Rokey's voice, irritation at Ray's casual disregard for what he had experienced. "You would be showing them a miracle that they're a million years away from still. In their reality if you die a little bit you're dead all over, and for keeps. You take that damn machine too much for granted!"

"You've seen too many movies, old man."

"This is no movie, Ray—blast it! You're the Fire-Bringer to these people now. Don't you realize what you'll be on this world ten thousand years from now??"

"Forgotten, that's what I'll be," Ray protested. "The Fire-Bringer will be the same myth he is anywhere else, and they'll make up the ending the way they want no matter what I do. Will you calm down? I have to show them how to put the fire safely out."

"There's more to fire than knowing how to strike it, Ray."

"What's that noise?" Ray said suddenly, standing up. "And you with your big ears. What's that noise?" He dashed off down the corridor to the stairwell and airlock.

The airlock opened to a scene of terror and chaos. Black smoke thick with cloying oils swirled in with a roar and shock of flames and screaming natives.

It was real this time, not an illusion of sound. The fire had spread, and the grass all around the ship was burning, an undulating wall of leaping flames that had trapped the natives between fire and the many teeth in the lake water. The starship ramp was the only safe ground left, and the natives were packed densely there. They fell into the ship in a wave of bodies and streamed in, shrieking with terror.

Before Rokey could speak, Ray leaped out into the smoke to make certain no one alive was left behind. He reappeared quickly, turned back by the rising flames, and raced up to the bridge. Rokey followed, calling anxiously, "Are you all right? Did you get scratched?"

"I'm okay," Ray replied breathlessly as he flung himself into the pilot's seat. He said nothing more as Rokey fired up the engines and the *Yankee Shadow* lifted away from the burning shore. Frightened screams still rang through the ship, and the smell of burnt fur and flesh was physical pain to Rokey.

From the air they could see more clearly what had happened. Individual fires had been lit in the grass all around the *Yankee Shadow*, until a huge bonfire party had spread in a ring across the meadow and along the dark lake shore. The natives had unwittingly trapped themselves at the center of a burning circle, trapped between death in the flames or death in the lake waters, with only the starship as escape.

Ray kept the ship hovering in clean air high above the lake, watching the grass fire burn itself out across the plain. The screaming on the ship stopped as the natives overcame their hysteria. They fell asleep eventually, curled up where they were, worn out by the enormity of these new events.

Ray sat unmoving at the dash, leaning forward and staring out the view shield at the fire below. Rokey escaped to his quarters, moving silently among

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the huddled creatures sleeping along the corridor. Many were clustered together in furred mounds, with their gliding membranes wrapped around their heads. He pushed aside a group on his bed and stretched out, easing the trembling in his bones. He lay staring at the trideo screen, deliberately ignoring the stinks of singed fur and flesh, and the wild rush of fear hovering in the air, deliberately ignoring the singed taste of his own conscience, deliberately ignoring the smoldering currents of his emotions, as tattered as Ray's last shirt.

He felt the ship move out of her hovering pause, felt her lift, and fly slowly. He listened for a bit and determined that they were not going into orbit. He pulled himself up, feeling the ache of genuine fatigue.

"I'm taking them closer to the equator," Ray said when Rokey came in. "I've been scanning for warm bodies down there, and there isn't much. Their people don't seem to have a big population yet. I think I can find them some territory that they won't have to fight for."

"You can't just take them back to their lake?"

"There's nothing left. The fire burned almost a thousand hectares."

"Grass fires are natural events, Ray. They must have some way of coping already."

"I want them closer to the equator," Ray said stubbornly. "I think they'd do better with a river system than just that little lake."

"Playing God, are you?" Rokey said darkly.

Ray's face was unreadable. "Apologizing," he replied finally.

Rokey chuckled. "Well, that's something gods don't do."

They cruised for several hours, watching the patternless green plain scroll by. Ray kept his attention on readouts, seeking his own particular vision of survival for the little natives now in his charge.

"This will do," Ray said at last, and began the descent. "I think those might even be some trees."

Jasper, with Ray's silver ring still on her tail, was the only one brave enough to follow Ray out the airlock. Her tail had been burned, and the long tufts of fur were gone, but she held it proudly as she walked beside him, her little hand clinging to his. Rokey remained at the top of the ramp, arms folded. The natives began to fill up the airlock, spilling out to cluster at the open edge to watch. They would not come near Rokey, afraid of him again, and kept a wary distance even as they crept out to see.

It was warmer here, but not dramatically. The long grass was deeper perhaps, more strongly perfumed. Ray had landed beside a broad, slow-moving river with a sloping bank and a single stand of meager trees along the water's edge. The whir of insect noises was strong, as though a symphony greeted them. The sun was bright, and the air of the river breezes sweet. Jasper clung to Ray, but she was trying to see everything at once, clearly entranced by this magically transformed landscape. She turned about eagerly, chattering at him in her own language.

Ray knelt, tugging at her hand for her attention, and touched the grassy earth at their feet. "Okay," he said to her. "Okay."

She patted his cheek with her tiny fingers. "What a pretty thing you are," she cooed to him. She bent down and happily rubbed her face and head and finally her entire body against the rich grass, as though swimming in it. "Okay! Okay!" she exclaimed as she stood up. She turned to look up to the open airlock, where the rest of her clan had gathered and were watching. She waved to them with a dramatic sweep of her skinflap, calling to them in commanding barks.

They poured out of the ship then, still avoiding Rokey but running eagerly down the ramp to the grass and this new land.

Rokey tried to get a clearer estimate

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of their number as he watched them spread out across the riverside, touching and tasting, exploring under the grass blades and calling eagerly to one another with each new find. There had seemed to be more when crowded together on the ship, but he guessed there were really only four or five hundred. It was a small clan, perhaps, but they appeared to have a sense of group integrity that relieved some of Rokey's deeper concern.

They were afraid to approach the water's edge. Ray picked up a fallen branch and waved it over the water. Everyone paused to watch him, and silence fell across the group. They knew this was important.

Nothing jumped out of the water at the motion. Ray touched the water's pewter-dark surface with the tip of the branch, but only ripples from the touch marred the river's calm. He then splashed vigorously, and no teeth jumped. He waded in for a step or two, flinching at the wet cold penetrating his boots. Nothing attacked him. He turned to the group, grinning broadly. "Okay! Water okay!"

They all ran down, spreading out along the shoreline, and knelt to drink, splashing in the shallows and calling happily. One of them caught some kind of large, fat worm in the mud there, and held up the prize with a squeal of delight. That caused a great stir of excitement. A picnic of fat worms ensued, with everyone digging in the mud along the shore, flinging it about and laughing. Rokey began to perceive the pattern of family groups by the way that the larger females would carefully wash off worms and hand them around to the smaller ones. The littlest ones were mostly playing in the mud, exploring it with their fingers, and throwing handfuls at each other. A half dozen of the largest males had spread through the group, and were clearly keeping an alert eye on the river and the trees. Females dug worms for these guards, washing the worms off first in the river and handing them up with coy gestures.

Ray at last climbed out of the water and back up to the ramp, to stand beside Rokey. "Okay, old man?"

Rokey chuckled. "I can live with it."

"So can they," Ray said.

"Go change your shoes," Rokey said to him.

Sitting there in the warm sunshine and drenched in river-sweet breezes, Rokey surrendered. Rules are rules, and the law is the law, but a child has to survive in order to grow up. The walls of ice were close, and even this little valley might not be secure. Rokey had to trust to Ray's experience with fleeting mortality.

By the time Ray returned, dry shod, Rokey had decided. "You go and teach them proper fire etiquette," Rokey said to him. "But one thing . . ."

"Yes, I know," Ray said. "Don't burn the trees." He was grinning.

Rokey felt a rush of paternal pride. "Can you teach them dead wood from live tree?"

Ray shrugged, his features registering a momentary, boyish distress. "I think so."

"Feeding the fire is okay," Rokey suggested. "Fire on trees is no-okay."

Ray laughed. "Something like that."

"Water on fire is no fire," Rokey went on, at last caught up in the game. "Don't forget that one."

"You're better at this than I am," Ray said in mock protest.

Rokey looked up at Ray solemnly, seeing him almost for the first time—not as an animal, not a pet, not a child, but as a man with a unique point of view, a man whose own walls of ice were not so far away. "You're doing just fine," Rokey said. "You teach them fire. I'll work on teaching them how to grow more trees."

"Thanks, partner," Ray said quietly.

Rokey recognized the gratitude on Ray's young/old face. "My pleasure," Rokey said. He meant it.■

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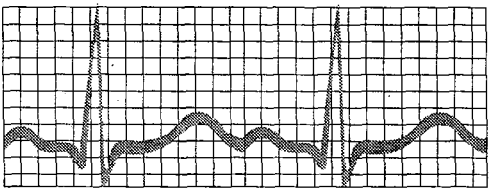
H.G. Stratmann, M.D.



Cardiovascular Medicine:

The Current State of the Heart

At heart, cardiovascular medicine is "just plumbing" —but what sophisticated plumbing!

Cardiovascular disease is the leading cause of death in the United States for both men and women. Every year it kills nearly a million Americans, including a third of the 1.25 million who have a heart attack (myocardial infarction, MI)*. Coronary artery disease (CAD) is the most common cardiovascular disease and the major cause of MI. Even when not fatal, CAD causes disabling chest pain and other symptoms in over 10 million people in this country alone. About 2 million Americans are treated for congestive heart failure (CHF), with 400,000 new cases identified annually. Uncontrolled hypertension (high blood pressure) causes serious damage to the brain, heart, and kidneys.

However, significant progress has been made recently to treat cardiovascular disease. Annual age-adjusted death rate from MI fell 31% between 1982 and 1991, and over the last 30 years the overall mortality from CAD declined 40%. Much of this improvement is due to public education and lifestyle modifications, including changes in diet and reduced cigarette smoking. New technologies to diagnose cardiovascular disease and sophisticated medical and surgical means to treat it have also contributed greatly to saving lives. This article summarizes the current status of cardiovascular medicine.

Basic Cardiac Anatomy and Function

The heart is roughly the size of a person's fist, and normally weighs about 325±75 grams in adult men and 275±75 grams in women. It's located behind the

** For convenience, acronyms and terms used in this article are defined, either directly or by reference to their first mention, in the Glossary at the end.*

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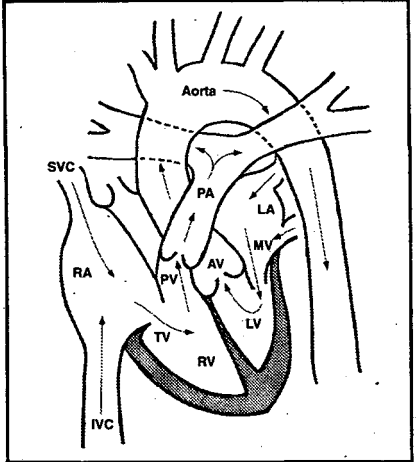
Figure 1



Chambers and valves of the heart. Arrows show direction of blood flow.
AV = aortic valve; IVC = inferior vena cava; LA = left atrium; LV = left ventricle; MV = mitral valve; PA = pulmonary artery; PV = pulmonic valve; RA = right atrium; RV = right ventricle; SVC = superior vena cava; TV = tricuspid valve.

sternum (breastbone) and the third, fourth, and fifth ribs on the left side of the chest. The heart is divided into two thin-walled upper chambers (atria) and two larger, thicker lower ones (ventricles). The walls of these chambers contain specialized muscle cells that contract and pump blood. Four valves— tricuspid, pulmonic, mitral, and aortic—regulate blood flow in the heart.

Blood with low oxygen content from the body's veins enters the right atrium from the superior and inferior venae cavae (Figure 1). This venous blood flows through the tricuspid valve into the right ventricle (RV), which pumps it into the pulmonary artery and through the lungs. There red blood cells rid themselves of excess carbon dioxide and increase the amount of oxygen they carry. Oxygenated blood enters the left atrium from four pulmonary veins, then goes through the mitral valve into the left ventricle (LV). The latter pumps blood through the aortic valve to the aorta, from which other arteries deliver oxygen and nutrients in the blood to the body's tissues and organs. A person's blood pressure and pulse are caused by this pumping action of the LV.

These events occur in a specific sequence. During *systole*, the RV and LV contract. The pressures this generates force the tricuspid and mitral valves closed, open the pulmonic and aortic valves, and allow blood to flow passively into and fill the atria. *Diastole* begins when the ventricles finish contracting and relax, causing the pulmonic and aortic valves to close. When the pressures in the relaxing ventricles fall below those in the atria, the tricuspid and mitral valves open and blood flows from the atria into the ventricles. Late in diastole the atria contract, forcing more blood into the ventricles—and then the cycle repeats.

The heart itself is supplied with blood by two arteries arising from the aorta just above the aortic valve. The right coronary artery provides blood to the RV and back (inferior) wall of the LV. The left main coronary artery quickly divides into two major branches, the left anterior descending and circumflex arteries, which supply blood to the rest of the LV. The LV is the main pumping chamber of the heart, and is larger and has a considerably thicker wall (about 1 cm) than the other three chambers. It therefore needs to be supplied with the most blood by these three coronary arteries—and is most vulnerable to injury if it doesn't receive enough blood.

Contraction of the atria and ventricles is stimulated by electrical impulses generated by cells within the heart. Normally the sinus node (located in the upper outer wall of the right atrium) regulates this, generating impulses at a rate of 60-100 times/minute in a resting person. These impulses travel to the ventricles through special conducting tissue.

Common Cardiovascular Diseases

In CAD, atherosclerotic plaques form

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in one or more coronary arteries. Plaques start with injury to the inner lining (intima) of these arteries, primarily due to hypertension, elevated cholesterol, and/or smoking. Early stages of atherosclerosis—yellowish fatty streaks on the intima—can begin by age 10. The most advanced stage is the fibrous plaque—a white elevated lesion jutting into the lumen of a coronary artery. Blockages ≥ 50% of the artery's diameter reduce blood flow enough that heart muscle (myocardium) doesn't always get enough oxygen. This "myocardial ischemia" occurs with exertion or emotional stress, and may not produce any symptoms. Often, however, it causes angina pectoris—"tightness" or "pressure" in the center of the chest typically lasting 5-10 minutes and relieved by rest. With more severe (≥ 70%) blockages, angina may occur at rest.

Blood clots (thrombi) can form on plaques, suddenly increasing how much an artery is narrowed—or block it completely. Unless adequate blood supply is restored within about 25 minutes, MI occurs, with permanent damage to the heart (primarily the LV). While most people have warning symptoms like angina before or when they have their MI, others don't ("silent MI").

Sometimes, a fatal MI is the first (and last!) indication a person has CAD. Death occurs quickly if too much myocardium is injured or, more commonly, abnormal heart rhythms (arrhythmias) that are too slow (bradyarrhythmias) or fast (tachyarrhythmias) make the heart beat too weakly to sustain life. Ventricular tachycardia and ventricular fibrillation are the most serious tachyarrhythmias, with the former often and the latter *always* requiring an electrical shock to the chest with a defibrillator to restore a more normal rhythm and save the person's life.

The risk of life-threatening ventricular tachyarrhythmias is greatest within the first hour of MI, but remains significantly increased for the next 23 hours. Patients who survive that early period remain at risk for recurrent chest pain, another MI, CHF—or death. The strongest single predictor for risk of dying during the first year after MI is how good the remaining heart function is. Mortality is only about 2% in those with normal left ventricular function, but nearly 50% when it's severely decreased.

CHF occurs when the heart can't pump blood well enough to meet the body's needs. It's usually due to decreased function or increased "stiffness" of the LV, and commonly produces shortness of breath, fatigue, and fluid retention. People whose heart has been damaged or weakened by CAD, hypertension, diabetes, or other causes are also, like those with an acute MI, predisposed to dying suddenly from ventricular tachycardia or fibrillation.

Hypertension is defined most simply as blood pressure that averages ≥ 140/90 mm Hg. The "silent killer", it usually causes no symptoms until it damages critical organs. Although hypertension is a major risk factor for CAD, CHF, and kidney failure, it's most strongly associated with causing strokes.

Valvular heart disease is now less common in the U.S., largely due to fewer cases of rheumatic fever. Treatment of streptococcal pharyngitis ("strep throat") with penicillin prevents rheumatic fever and the narrowing (stenosis) and leaking (regurgitation) of mitral and aortic valves it can cause 10-20 years later. However, other causes of valve damage remain. Aortic stenosis due to calcification of the valve becomes increasingly prevalent after age 50. When severe and associated with CHF, half of untreated patients die within 2 years. Aortic and mitral regurgitation due to age-related valve degeneration, endocarditis (infection of the valves), etc. can also cause CHF and death.

Nonfatal arrhythmias due to structural or conduction abnormalities in the heart can cause disabling symptoms. Moderately severe or transient brad-

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yarrhythmias may produce shortness of breath or temporary loss of consciousness (syncope). Atrial fibrillation, a tachyarrhythmia, occurs predominantly in the elderly—5% of people ≥ 70 years old have it. It causes difficulty breathing and limits ability to exercise by making the heart beat too fast and preventing the atria from contracting. Atrial fibrillation also carries, on average, a 5% yearly risk of stroke due to "pooling" of blood in these noncontracting atria with formation of thrombi that break off, travel through arteries to the brain, and block off its blood supply.

Diagnosing Cardiovascular Disease

Evaluation begins with determining if a patient has symptoms suggesting cardiovascular disease. For example, a history of typical angina in a man ≥ 40 years old indicates a high likelihood of CAD, especially if major risk factors like smoking or diabetes are present. A good physical examination, including measuring blood pressure and listening for abnormal sounds in the lungs and heart with a stethoscope, is also essential.

Often simple tests provide useful information. The electrocardiogram (EKG) records the heart's electrical activity (including its rhythm), and can detect myocardial ischemia and a new or old MI. A chest X-ray may show enlargement of the heart and fluid in the lungs, often seen in CHF. Serum levels of creatine phosphokinase (especially its MB isoenzyme or MB_2 isoform), myoglobin, troponin I, and troponin T rise when myocardium is destroyed, and blood tests for them are used to detect an acute MI. A high total cholesterol, and especially an elevated blood level of low-density lipoprotein or decreased level of high-density lipoprotein (both of which transport cholesterol in the body), are important risk factors for CAD.

Cardiac Imaging and Stress Testing

More sophisticated tests are often necessary, however, to diagnose and evaluate severity of cardiovascular disease. *Transthoracic echocardiography* is the main test used to image the heart. Ultrasonic waves at a frequency of 2 to 5 MHz generated by a transducer placed on the chest bounce off the heart's walls and valves. The time it takes for the reflected ultrasound beam to return to the transducer is used to determine how far away a part of the heart is—the nearer it is, the less time it takes for the reflected beam to reach the transducer. This information can be displayed graphically on paper or as images on a video monitor.

Over the past two decades, more powerful computerized image-processing and new technical refinements and methods have greatly increased echocardiography's ability to evaluate the heart. In *two-dimensional echocardiography*, "slices" of the heart are taken from different angles, and images are recorded as a "movie" on videotape. Abnormalities of the structure, motion, or size of the heart's chambers and valves can be detected, as well as thrombi and tumors within the heart and fluid around it (pericardial effusion). *Doppler echocardiography* detects blood flow within the heart, displaying its direction and velocity graphically or by "color-coding" them to identify abnormal flow patterns.

With *transesophageal echocardiography* (TEE), the patient swallows a hoselike probe with a transducer on its end. Image quality is much better with TEE than the standard transthoracic method due to the shorter distance between transducer and heart. This reduces attenuation of the ultrasound beam and allows higher frequencies to be used, improving the resolution of images. TEE is also useful for examining areas of the heart difficult to see by transthoracic echocardiography.

Stress testing is used primarily to evaluate patients with known or suspected CAD. It has evolved from the Master two-step test (a person walked continuously up and down two steps to see if they got

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Table 1. Major classes of cardiovascular medicines

Class	Primary uses	Examples
Beta-blockers	CAD, HBP, CHF, AF	Propranolol, metoprolol, atenolol, carvedilol
Calcium antagonists	CAD, HBP, AF	Verapamil, diltiazem, nifedipine, felodipine
Nitrates	CAD, CHF	Trinitroglycerin, isosorbide mono- and dinitrat
Angiotensin-converting enzyme inhibitors	CAD, CHF, HBP	Captopril, enalapril, lisinopril, fosinopril
Angiotensin receptor antagonists	CAD, CHF, HBP	Losartan, valsartan, irbesartan
HMG-CoA reductase inhibitors	Elevated low-density lipoprotein cholesterol	Lovastatin, pravastatin, simvastatin, atorvastatin
Antiarrhythmics	Tachyarrhythmias	Quinidine, procainamide, flecainide, amiodarone, sotalol, lidocaine
Diuretics	CHF, HBP	Hydrochlorothiazide, furosemide
Antiplatelet agents	CAD, AF	Aspirin, ticlopidine
Anticoagulants	CHF, CAD, AF	Warfarin, heparin
Thrombolytics	Acute MI	Streptokinase, alteplase, reteplase

AF = atrial fibrillation; CAD = coronary artery disease; CHF = congestive heart failure; HBP = high blood pressure; MI = myocardial infarction.

angina) in the late 1920s, to treadmill and bicycle exercise with EKG monitoring (1960s), nuclear imaging techniques (late 1970s), and pharmacological stress testing and echocardiography (late 1980s). It's most useful when a person's symptoms and risk factors suggest an "intermediate" (10-90%) likelihood of having CAD. An abnormal stress test can reliably change them to a "high" (> 90%) and a normal one to a "low" (< 10%) likelihood of having significant CAD, and helps separate patients requiring further testing or treatment from those who don't.

A basic exercise stress test involves walking on a treadmill at increasing speeds and elevations while monitoring heart rate, blood pressure, and the EKG. Exercise increases the work the heart does, and thus the blood flow and oxygen it needs. If enough blood doesn't get through a partially blocked artery, myocardial ischemia will occur, producing characteristic changes on the EKG (e.g. ST segment depression). Besides diagnosing CAD, exercise testing also provides prognostic information. The greater the level of exercise a person

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can do, the less their chance of having an MI or dying from heart disease in the near future—and vice versa.

However, exercise-induced EKG changes will, on average, identify only about 65% of patients with CAD; don't usually indicate what part or how much of the heart isn't getting enough blood; and occasionally indicate CAD is present when it isn't ("false positive"). Combining exercise with myocardial perfusion imaging (MPI) or echocardiography detects CAD in about 90% of patients and reliably localizes ischemia.

MPI involves injecting thallium-201 or newer agents like technetium-99m sestamibi or tetrofosmin intravenously. These radionuclides are taken up by the heart, with the amount of uptake roughly proportional to how much blood an area of myocardium receives. The radiation they produce is detected by a gamma scintillation camera. Images are then generated showing if any parts of the heart aren't getting enough blood, indicating CAD. Pictures obtained after injecting one of these agents while a person is exercising vigorously are compared to those obtained when the heart isn't under stress. Areas showing decreased radionuclide uptake that's similar on both rest and stress studies indicate either dead or severely ischemic myocardium. If abnormal areas seen after stressing the heart show better uptake on rest images, however, this is consistent with myocardial ischemia, and suggests the need for further treatment.

Due to the short half-lives of these agents (73 hours for thallium-201 and 6 hours for technetium-99m) and the small doses used, radiation exposure to the patient having MPI is low—about the same as getting a chest X-ray.

Improved image quality with MPI has, as with echocardiography, paralleled the availability of more powerful computer processing. The low-resolution "planar" heart images that were the standard a decade ago have been supplanted by two-dimensional (tomographic) computer-reconstructed studies. Equipment is now available to generate sophisticated three-dimensional images showing myocardial blood flow.

Echocardiography can also be used with stress testing. Each wall of the LV is imaged and evaluated before stress to see if it's contracting and thickening normally with each heart beat. Images are repeated immediately after exercise. If part of the LV doesn't move as well post-exercise, this indicates myocardial ischemia occurred and CAD is present.

Patients with limited ability to exercise and stress their hearts (e.g. those who get leg pain with walking due to arthritis) are tested by injecting medications that dilate coronary arteries (dipyridamole, adenosine) or stimulate the heart (dobutamine, arbutamine). Unlike exercise testing, these tests don't usually cause abnormal EKG changes. However, when used with MPI or, with dobutamine and arbutamine, echocardiography, they can detect CAD as reliably as exercise testing.

Several cardiac imaging tests are used less frequently. *Positron emission tomography* (PET) uses positron-emitting radioisotopes to scan the heart for blood flow (e.g. using ^{13}N ammonia), and identify living ("viable") myocardial cells by their uptake of glucose, amino acids, and other substances which they metabolize (e.g. with ^{18}F-fluorodeoxyglucose). It's the most reliable method for differentiating dead myocardium (abnormally reduced blood flow and metabolism) which can't be treated, from severely ischemic ("hibernating") myocardium (reduced blood flow but with evidence of metabolism) which can.

Magnetic resonance imaging (MRI) uses a powerful electromagnet and radiofrequency pulses to make nuclei (particularly hydrogen) in the body absorb and release energy. Analysis of the energy emitted by nuclei allows production of high resolution two-dimensional images based on the location and intensity of the received signals. Cardiovascu-

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lar applications include identifying old or new MIs, visualizing coronary arteries, assessing blood flow through coronary bypass grafts (see below), and evaluating anatomic abnormalities like dissection (tearing) of the aorta.

Spiral and ultrafast *computed tomography* (CT) scanners use X-rays to take two-dimensional images of the heart. Most applications are similar to MRI. CT also detects calcification in coronary arteries, suggesting CAD. Imaging usually requires intravenous injection of an iodine-containing "contrast agent", which occasionally causes allergic reactions or kidney failure.

Use of PET, MRI, and CT for cardiac imaging is limited by the large size and high cost of scanners; ability of simpler tests like echocardiography to provide similar information; and, for PET, the need for an on-site cyclotron to produce most of the radioisotopes with very short half-lives it requires.

Coronary Angiography

The "gold standard" for diagnosing CAD is coronary angiography. About 1.2 million studies are done in the U.S. annually. In this procedure, a catheter (a long thin tube about 2-3 mm in diameter) is inserted into an artery in the leg or arm, and advanced to the heart using a fluoroscope for guidance. A radiopaque contrast agent is injected through the catheter into a coronary artery during fluoroscopy. X-ray images are recorded as a movie on 35 mm film or, with newer systems, in a digital format. Blockages in arteries are identified as areas where the flow of contrast is restricted.

Coronary angiography sometimes underestimates the severity of blockages. It's also generally not as reliable as stress testing with MPI or echocardiography for assessing how much individual blockages impair blood supply. Risk of MI, stroke, or death during angiography is 1 out of 1000, compared to about 1 in 20,000 with stress testing.

Coronary artery blockages can also be visualized directly. With *intravascular ultrasound*, a catheter fitted at the end with a small ultrasound transducer is advanced into an artery. Two- or three-dimensional images of blockages are obtained using a process similar to conventional echocardiography. *Coronary angioscopy* employs a catheter with a fiberoptic imaging bundle which directly transmits pictures from inside arteries to an external video monitor. The artery must be blocked briefly with an inflatable balloon at the end of the catheter and saline injected into it, displacing blood. Both techniques are relatively costly and time-consuming, however, and catheters can't be advanced into smaller arteries.

Medical Treatment of Cardiovascular Disease

The most powerful and useful cardiac medications (Table 1) have been available for only about 20 years. Beta-blockers, calcium antagonists, and angiotensin-converting enzyme (ACE) inhibitors are highly effective for improving symptoms in patients with CAD and CHF and controlling hypertension. Aspirin, beta-blockers, and ACE inhibitors reduce risk of dying both at the time of an acute MI and, with long-term use, for years afterwards. ACE inhibitors and carvedilol improve survival in patients with moderate to severe CHF. In healthy adults with even only modestly elevated serum cholesterol, 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase inhibitors reduce the chance of developing CAD or having an MI. In patients with known CAD (especially those surviving an acute MI), these drugs decrease the rate at which coronary blockages worsen and lower the risk of dying, stroke, or having another MI. Warfarin and aspirin reduce the risk of stroke in patients with atrial fibrillation.

Thrombolytic therapy has revolutionized treatment of patients having an acute MI. These intravenous medications dissolve blood clots in a blocked coronary artery, restoring blood flow and pre-

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venting further damage to the heart. They are most effective when given as early as possible after the MI starts, but are still beneficial up to 12 hours later. Thrombolytic drugs save an average of 18 lives out of every 1000 patients treated, and up to 49 out of a 1000 in those with "high-risk" EKG abnormalities. While they can cause bleeding, overall risk of serious side effects is small.

Valve Replacement

Severely damaged heart valves (especially the mitral and aortic) may require replacement with a prosthetic valve. Used since the early 1960s, the Starr-Edwards is the prototypical "mechanical" valve. It consists of a metal cage with a silicone rubber ball (poppet) inside that moves back and forth, "opening" and "closing" the valve to regulate blood flow. Since the 1970s this "caged-ball" valve has been supplanted by smaller "tilting disk" valves. With them, one or two circular or semicircular disks pivot in a metal ring.

Mechanical valves are extremely durable, with some patients now surviving for several decades. However, as a foreign body, they can cause an infection where they're sewn into the heart. Also, thrombi can form on them, which can occlude the valve or break off and cause strokes. Lifelong "anticoagulation" treatment with warfarin is necessary to reduce these risks, but at the price of a small risk of serious bleeding.

Bioprosthetic valves have been used since the mid-1960s. Usually, a pig's aortic valve is fixed and preserved in glutaraldehyde, then placed in a supporting strut. The advantage of these valves is that anticoagulation therapy isn't necessary. However, they're not as durable as mechanical valves. On average about 30% will show severe deterioration after 10 years, necessitating repeat operation. Failure rate is much higher than this in patients ≤ 40 years old, and lower in those > 70. Thus, these valves are usually reserved for the elderly.

Coronary Artery Bypass Surgery

First performed in 1964, coronary artery bypass graft (CABG) surgery has become the primary operation used to treat CAD. Over 300,000 CABG operations are done in the U.S. annually, at a cost of over 50 billion dollars. Standard techniques require a sternotomy (opening the chest by sawing lengthwise through the sternum), temporarily stopping the heart, and using a cardiopulmonary bypass (heart-lung) machine. One end of a vein taken from the leg is sewn into the aorta and the other end into a coronary artery beyond a blockage, "bypassing" it and improving blood supply to the heart. Alternatively, the end of an internal mammary artery in the chest is sewn into the diseased coronary artery instead.

"Minimally invasive" bypass methods that don't require sternotomy are currently being evaluated. These generally involve making a relatively small incision in the left chest to visualize the still-beating heart and bypassing a diseased left anterior descending coronary artery with the left internal mammary artery. Preliminary results are encouraging, with patients recovering more rapidly with much smaller scars and fewer complications than the "standard" method. However, not all areas of the heart can be reached by this technique, and there is limited ability to use other arteries in the chest or veins for bypass.

CABG improves or eliminates angina in up to 95% of patients who have disabling symptoms despite maximum tolerated doses of medication. In those with severe CAD involving the left main or all three coronary arteries, CABG is also better than medical therapy for reducing long-term risk of death.

Unfortunately, CABG is neither risk-free nor a permanent solution. Average mortality rate for the operation is 2.2%, and exceeds 10% in high-risk patients. Postoperative complications include bleeding, stroke, infections, and kidney failure. By 5 years after surgery, 75% of

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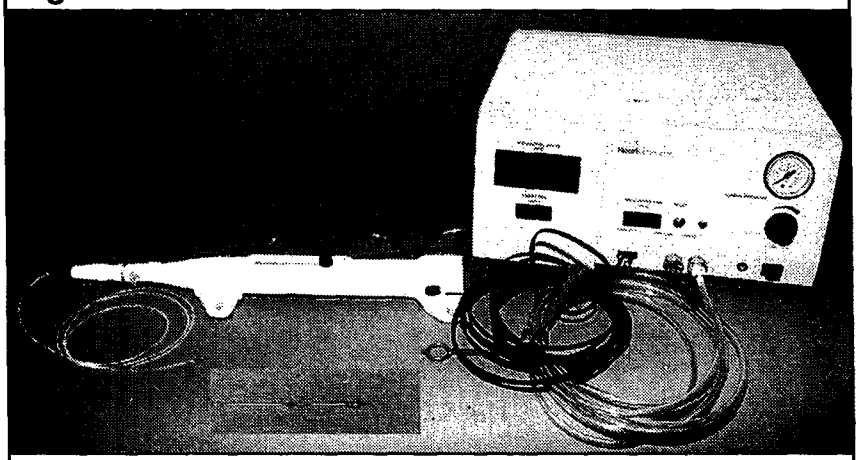
patients haven't had an MI, died suddenly, or had a return or worsening of angina. However, this figure drops to 50% by 10 years post-CABG, and 15% at 15 years. This diminishing benefit over time is mainly due to development or worsening of atherosclerosis in arteries not initially needing bypass, in bypassed arteries beyond where the graft is inserted, and in the grafts themselves. Internal mammary grafts have a 90% chance of staying open after 10 years. However, only two such arteries are present in the chest, and they can't be used to bypass blockages in certain locations. Vein grafts don't have those limitations but are much less durable—each one used has at least a 50% chance of closing within 10 years after CABG.

Figure 2



Rotoblator system for rotational coronary atherectomy (see text). A burr 1.25-2.50 mm in size (see insert for close-up) is welded to a thin flexible drive shaft extending from the housing unit (left). Device console (right) to adjust and display burr rotation speed connects to the housing unit and a compressed-air-powered turbine (not shown).

Coronary Angioplasty

First performed in 1977, percutaneous transluminal coronary angioplasty (PTCA) is now used to treat CAD as often as CABG, and is much less invasive. PTCA uses the same catheterization technique as coronary angiography. However, the catheter used has an inflatable balloon about 2 cm long at its tip. After it's advanced into a coronary artery blockage, the balloon is inflated briefly under high pressure, widening the artery and allowing more blood to get through. Initial success rate of PTCA (defined as > 20% improvement in the degree of narrowing in an artery, with a final blockage that's < 50%) is as high as 90-95%. Complications like nonfatal MI, emergency CABG due to vessel damage, or (rarely) death occur on average in about 5% of patients.

Compared to CABG, PTCA requires a shorter hospital stay, and is more easily repeated and less stressful on patients. At least initially, it's less costly than CABG and relieves angina just as frequently. Patients eligible for both procedures have similar overall survival and MI rates. PTCA is also considered the treatment of choice for opening blocked arteries within the first hours after an acute MI, especially in patients who can't be treated with or don't respond to thrombolytics. It can open partially blocked vein grafts from previous CABG, preventing or at least delaying a repeat operation.

However, more than half of coronary blockages can't be reached for PTCA, and many of those that can have characteris-

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tics (e.g. > 2 cm long or heavily calcified) which significantly reduce success rate. The greatest shortcoming of PTCA is that 30-50% of blockages successfully dilated develop "restenosis"—an increase in narrowing back to ≥ 50%, and sometimes *worse* than it was before PTCA—within 6 months after angioplasty, usually making angina return or worsen. PTCA of vein grafts, especially those > 3 years old, has only a modest initial success rate, and a high restenosis rate. While repeating PTCA of blockages is also usually successful initially, restenosis can occur again. Overall, 40% of patients need another PTCA and 20% require CABG within 3 years to treat recurrent angina after a first, "successful" angioplasty.

Over the past 15 years, new methods have been developed to deal with the shortcomings of PTCA. *Directional coronary atherectomy* (DCA) uses a catheter with a metal cylinder at one end that's partially open on the side. It contains an electric cutting unit with a small blade, connected through a drive cable in the catheter to an external motor and power source. After it's positioned in a partially blocked coronary artery, the blade spins at about 2000 rpm, "shaving" off atherosclerotic plaque and collecting the debris in a hollow cone at the tip of the catheter. DCA is most useful when many blockages are present throughout a coronary artery.

Transluminal extraction atherectomy (TEC) is a modification of DCA. Plaque and thrombus in a coronary artery or vein graft are excised by two blades rotating at 750 rpm, then sucked back through the catheter using a vacuum aspiration system to a collection bottle. This system efficiently collects and removes loose debris in these vessels which would otherwise travel "downstream", occluding the vessel and potentially causing MI. It's especially useful for dealing with partially blocked vein grafts.

Like DCA and TEC, *rotational coronary atherectomy* removes ("debulks") material in coronary arteries and grafts (Figure 2). Instead of cutting plaque, however, the Rotoblator abrades and grinds it away. At the end of the Rotoblator is a burr coated with diamond microchips that spins at up to 200,000 rpm. This technique works well in heavily calcified plaques which often don't respond adequately to balloon angioplasty.

First performed in 1983, *excimer laser coronary angioplasty* (ELCA) uses bursts of ultraviolet light from an external XeCl laser. They're transmitted through fiberoptics inside a catheter after positioning its tip against a coronary blockage. The laser actually produces little heat, and doesn't remove plaque primarily by "zapping" it. Instead, it works more "gently" by photochemical disruption of molecular bonds and direct desorption of plaque material, and producing photoacoustic "shock waves" which fragment it. ELCA is most useful for totally occluded arteries and blockages ≥ 1 cm long.

Unfortunately, most studies comparing DCA, ELCA, etc. to balloon angioplasty have shown that these newer methods are no better than conventional PTCA for opening up most coronary blockages, have similar rates of restenosis, and may have higher complication rates (e.g. cutting through the wall of a coronary artery). These methods are also more costly and difficult to perform, and can only be used in relatively large coronary arteries (≥ 3 mm diameter). Their use is primarily limited to blockages considered "high risk" by balloon angioplasty.

However, a relatively "low tech" device first used in 1986 *is* very effective for improving the initial success rate of balloon angioplasty and reducing risk of restenosis. A *coronary stent* is a slotted tube, coiled wire, or wire mesh made of stainless steel or tantalum. It averages 3.0-4.0 mm in diameter and 15-20 mm long. Most are premounted on a balloon catheter. This balloon-stent system is placed in a coronary blockage just after dilation by conventional PTCA, DCA, etc. The bal-

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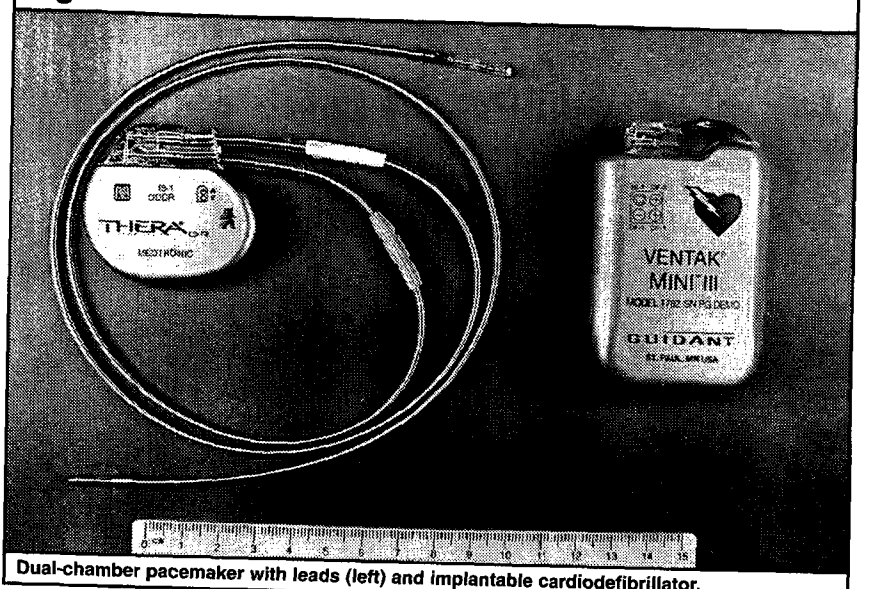
Figure 3



Dual-chamber pacemaker with leads (left) and implantable cardiodefibrillator.

loon is then inflated, expanding the stent and pressing it firmly against the wall of the coronary artery to keep it open. When PTCA causes a "dissection" or tearing of the wall of an artery, emergency placement of a stent significantly reduces the chance the artery will become blocked off from local bleeding and thrombus formation, causing MI.

Stents are foreign bodies. They produce a local inflammatory response and site where thrombi can form, leading to restenosis. This risk is highest within the first several weeks after placement, then decreases greatly due to formation of protective tissue on the stent's surfaces ("endothelialization"). One old and two new types of "blood thinning" medications reduce the chance of restenosis in some lesions to as low as 10% at 6 months after stent placement. Aspirin and ticlopidine are taken orally for 3-6 weeks post-stenting, followed by lifelong use of aspirin alone. A monoclonal antibody, abciximab, given intravenously for 12 hours after "high risk" stent procedures also reduces risk of restenosis.

Several investigational techniques might also prove useful. Stents made slightly radioactive by coating them with short-lived radionuclides producing beta or gamma radiation may inhibit injury-induced intimal cell proliferation caused by PTCA, which is a major contributor to restenosis. A new catheter now being studied produces 20 kHz ultrasound at its tip. Placed against a coronary blockage it could, like an opera singer shattering a glass, break up atherosclerotic plaque.

Transmyocardial laser revascularization (TMLR) can be used when CAD is too severe for treatment with CABG or PTCA. The tip of a CO_2 or holmium laser is placed against the outer surface of the LV through a chest incision. Laser pulses burn channels 1 mm in diameter completely through the wall, allowing blood from inside the heart to enter the myocardium and directly perfuse it. This process may also stimulate production of new small blood vessels within the myocardium, further improving its blood supply. Most patients treated with this procedure have had significant improvement in their symptoms.

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A less invasive alternative, *percutaneous TMLR*, is now being evaluated. A laser catheter similar to that used for ELCA is inserted into a leg artery, advanced to the heart, and its tip positioned against the *inner* surface of the LV. A holmium laser burns channels only halfway instead of completely through the myocardium. Compared to the standard transmyocardial method, this technique doesn't require a chest incision or general anesthesia, and is potentially safer.

Cardiac Transplantation

The first successful human heart transplant was done in 1967. Surgical techniques for the procedure were quickly refined, and the risk of the operation itself is relatively low. However, for patients transplanted between 1967 and 1971, the chance of living for one year after surgery was only *15%* due to rejection of the transplanted heart, and infections caused by the immunosuppressive medications needed to prevent rejection.

Since then, new techniques for early diagnosis of rejection like endomyocardial biopsy (intravenous insertion of a bioptome to take tiny samples of myocardium for examination) and medications for preventing (cyclosporine, tacrolimus) and treating it (antithymocyte globulin, OKT3) have dramatically improved outcome after heart transplantation. Currently, up to 95% of patients are alive after one year, and over 65% after 5 years.

Early development of atherosclerosis in the arteries of the transplanted heart is the major long-term problem associated with the procedure. CAD develops as soon as 3 months after transplantation, and after 5 years about half of patients have it. While blockages may be treatable with PTCA or CABG, often they're too severe and widespread—and a second heart transplant must be considered.

A limited supply of donor hearts means that transplantation is often delayed. Several devices, like the intra-aortic balloon pump and ventricular assist device (VAD), can stabilize ("bridge") patients temporarily before transplantation. The VAD is a mechanical pump using a roller, centrifugal, or pulsatile system that takes over the function of a failing ventricle. Usually, a large cannula is inserted into the left atrium or LV and directs blood into the VAD, which then pumps it back through another cannula inserted into the aorta and from there to the rest of the body. Most current VADs lie completely outside the body, although an implantable pump with an external drive unit is available. Completely implantable VADs using an electric pulsatile pump system which can be used for months and allow full patient mobility are now being tested.

A total artificial heart has been placed in several hundred patients awaiting transplantation. The unit is implanted in the chest after removal of the patient's own heart. It consists of two pneumatic pumps connected by a pair of tubes to an external drive unit, which periodically sends air pulses to flexible blood sacs that make them "contract". Serious problems with infections and thrombus formation limit its use. A fully implantable electric artificial heart requiring only an external battery supply is currently being developed.

Less drastic surgical procedures to treat patients with damaged hearts are also being evaluated. *Cardiomyoplasty* involves rotating a muscle in the back (the latissimus dorsi) and wrapping it around the heart. A pacing device stimulates this muscle to contract periodically and assist the weakened heart's own contractions. The *Batista procedure* involves excising part of a markedly enlarged, thickened LV. The remaining, smaller chamber can work more efficiently, improving the patient's symptoms and longevity.

Pacemakers

Pacemakers (Figure 3) are used to treat bradyarrhythmias caused by damage or disease of the sinus node and spe-

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cialized conducting tissue of the heart. A battery-powered generator sends electrical pulses through a long thin lead with one or two electrodes in contact with a heart chamber (usually the RV), stimulating it to contract at a "normal" rate. Unlike the bulky units introduced in the late 1950s, pacemakers are now small, light, and easily implanted just below the clavicle (collarbone), with their leads inserted through a vein and advanced to the RV. Their lithium-iodine batteries last up to 12 years.

"Dual-chamber" models with electrode leads in the right atrium *and* RV increase the efficiency with which the heart beats compared to pacing the RV alone. The newest "rate-adaptive" pacemakers aren't limited to pacing the heart at a fixed rate. They increase heart rate in a more normal fashion using sensors that detect when a person breathes harder or their temperature rises during exercise. All current permanent pacemakers contain transceivers that allow their settings for pacing rate and other parameters to be "interrogated" and changed by a signal from an external programming device.

Implantable cardiodefibrillators (ICD) are pacemaker-like devices used to detect and treat ventricular tachycardia or fibrillation. All use a battery-capacitor system that charges and delivers a shock (about 30 joules) through an electrode lead in contact with the heart to terminate the tachyarrhythmia. Some units can also interrupt ventricular tachycardia without delivering a shock by briefly pacing the heart at a fast rate ("antitachycardia pacing").

Because of their size and weight, the first ICDs were placed in the abdomen, and connected by wires placed under the skin to electrode patches sewn on or over the heart. Current ICDs aren't much larger than a regular pacemaker and are implanted the same way. ICDs are considered as or more effective than the best available medications for improving survival in patients at high risk for developing life-threatening ventricular tachyarrhythmias.

Surgical procedures are sometimes needed to treat serious tachyarrhythmias originating in the atria or ventricles. *RF ablation* uses a catheter passed through a vein or artery into the heart that generates radiofrequency energy at its tip. It literally burns away tiny areas of heart tissue that cause or worsen the arrhythmia. More difficult cases may require opening the chest and directly cutting away, freezing (using a cryoprobe at -60 ° C), or vaporizing abnormal tissue with a laser.

Future Directions

Extensive research is being conducted to develop new medications and procedures for treating cardiovascular diseases, and better define the uses of existing ones. Genetic engineering techniques are currently used to produce monoclonal antibodies, thrombolytic agents, and other drugs. Genes encoding for vascular endothelial growth factor or other substances that stimulate growth of new small blood vessels might, if transferred to the heart, improve blood supply to ischemic myocardium in patients with severe CAD. Stents coated with a patient's own cloned endothelial cells might reduce risk of restenosis after PTCA.

Early identification of individuals genetically predisposed to cardiovascular disease could prove beneficial. About 10% of people have a genetic mutation causing mildly elevated blood levels of homocysteine, which is associated with increased risk of CAD. Treatment with inexpensive vitamins (B_{12} and folate) might reduce this risk. Gene therapy, with transmission of normal genes to the affected patient (e.g. by a retrovirus vector), could be used to treat more serious diseases like familial hypercholesterolemia, which leads to severe atherosclerosis at an early age.

In patients with severely weakened hearts and CHF, the body inappropriately produces increased levels of tumor necrosis factor, endothelin, and other

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chemicals which may worsen their condition. New medications are now being developed and tested to counteract their deleterious effects.

Finding new medicines to prevent or eliminate atherosclerosis is a high priority. Recently, the intriguing possibility has been raised that CAD is at least partly due to inflammation of coronary arteries from chronic infection. Viruses like cytomegalovirus and bacteria (*Chlamydia pneumoniae* and *Helicobacter pylori*) have been identified in atherosclerotic plaques, and acute infection with *C. pneumoniae* may trigger an acute MI. *H. pylori* was recently established as a major cause of gastric and duodenal ulcers, and eradication of the organism with antibiotics is effective for treating them. Several recent studies suggest that antibiotic treatment for *C. pneumoniae* might also be used to treat CAD.

Even if methods are developed to prevent atherosclerosis and eliminate hypertension and other diseases that damage it, the cardiovascular system "normally" deteriorates with increasing age. The heart and blood vessels become stiffer and work less efficiently, cardiac valves and conducting tissue calcify and degenerate, myocardial cells die and can't be replaced. Advanced genetic engineering will be needed to deal effectively with these problems and—assuming the even more formidable tasks of preventing cancer, infections, neurological deterioration, etc. can be solved—reliably extend healthy human life span beyond a century or so.

Summary

Most of you reading this article are more likely to die from cardiovascular disease than any other cause. CAD, CHF, hypertension, etc. are often due to risk factors you can't avoid, like diabetes or your age, gender, and genetic predisposition.

Fortunately, many new procedures and medications are now available to detect and treat cardiovascular disease, and even better ones are being developed. More importantly, there are many things *you* can do to help yourself. A prudent lifestyle that includes moderate exercise, a diet with healthy levels of calories, cholesterol and salt, regular check-ups by your doctor, and avoiding smoking and excessive alcohol can significantly reduce your chance of needing to visit your friendly neighborhood cardiologist. While it's comforting to know that I and my medical colleagues have so many wonderful ways of taking care of you, it's better *not* to wind up on the business end of a catheter or surgeon's scalpel if you can possibly avoid it!■

Glossary

Angina pectoris: Chest pain due to myocardial ischemia (see below).
Atherosclerosis: Blockages in arteries resulting primarily from injury and elevated blood cholesterol.
Bradyarrhythmia: An abnormal slow (< 60 beats/minute) heart rhythm.
CABG (Coronary artery bypass grafting): Page 37, column 2.
CAD (Coronary artery disease): Blockages (usually due to atherosclerosis) in one or more of the arteries providing blood to the heart.
CHF (Congestive heart failure): Inability of the heart to provide enough blood to meet the body's needs, usually due to damage to the heart.
Coronary angiography: Page 36, column 1.
DCA (Directional coronary atherectomy): Page 39, column 1.
Echocardiography: A test for imaging the heart using ultrasonic waves.
EKG (Electrocardiogram): A test used to record the heart's electrical activity.
ELCA (Excimer laser coronary angioplasty): Page 39, column 2.
ICD (Implantable cardiodefibrillator): Page 42, column 1.
LV (Left ventricle): The main pumping chamber of the heart.

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MI (Myocardial infarction): Permanent damage to part of the heart.
MPI (Myocardial perfusion imaging): Page 34, column 1.
Myocardial ischemia: Reduction of blood supply to heart muscle below the level it needs to function properly.
Myocardium: Heart muscle.
Pacemaker: A device for generating electrical impulses that make a heart chamber contract.
PTCA (Percutaneous transluminal coronary angioplasty): Page 38, column 1.
RV (Right ventricle): The heart chamber that pumps blood to the lungs.
Tachyarrhythmia: An abnormal fast (> 100 beats/minute) heart rhythm.
Thrombus: A blood clot.
TMLR (Transmyocardial laser revascularization): Page 40, column 2.
VAD (Ventricular assist device): Page 41, column 2.
Ventricular fibrillation: An abnormal fast (> 400 beats/minute) heart rhythm that makes the ventricles "quiver" (fibrillate) instead of contracting and pumping blood.
Ventricular tachycardia: An abnormally fast (120 to 400 beats/minute) heart rhythm originating in a ventricle.

Suggested Reading

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Acknowledgments

The author wishes to thank Ms. Toni Moore, Mr. Ken Phelan, Lisa Schiller, M.D., and Saad Bitar, M.D. for providing the devices shown in this article's illustrations.

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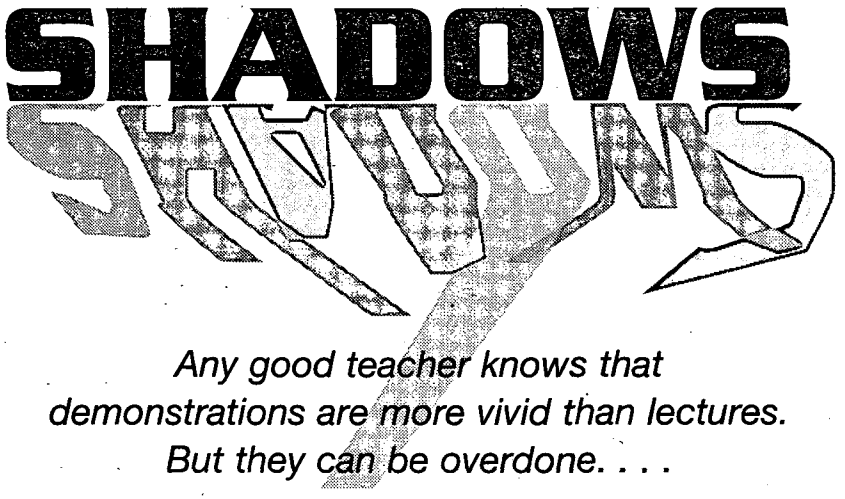
James C. Glass



Any good teacher knows that demonstrations are more vivid than lectures. But they can be overdone. . . .

Tom Hadley and I met for breakfast in the fourth floor cafeteria of Feynman Hall. Tom is my department head, and we've been friends for twenty years, but I was still apprehensive about the meeting, even as we put down our bagels and cream cheese at a table next to the window overlooking University Park and the Building E collision area only a hundred meters away. Brilliant sunshine, geometric patterns of sculpted lawns and flower beds below us, students hurrying to their first class, all so normal, all so unchanged.

"I wanted to talk to you about this afternoon," said Tom.

"John McCluskey's mother?"

He nodded. "She called me first about meeting you, and I said fine. But you and I need to talk first."

My mouth was lint dry when I answered. "She wants to know what happened to her son, and I'm going to tell her."

Tom spread cream cheese on his bagel, avoiding eye contact. "You can tell her what you saw, Erv. Anything else will be conjecture. We don't know what happened."

"This thing can't be covered up, Tom. There were sixty students in that room with me, and they're all talking," I said.

"They can only tell what they saw, Erv. Everybody's scared, and this is a forty-billion-dollar-project. The feds flew in an investigative team last night, and now nobody is saying anything. Do you understand?"

"I understand that a student is gone and his mother wants to know why. What energy did they get to, Tom?"

Tom chewed, and shrugged. "I got hold of Hendrickson two nights ago, and he was still shaking. He thinks they got the X boson for sure, and might have come close to the Higgs. He wasn't even sure they got any data. The control room was chaos; they found themselves in the middle of a street with cars veering all over the place, flickering in and out until the third shot and then it was like they were really *there*. The radiation monitors started screaming and they watched a pedestrian get crunched by two cars right in the middle of the control room. That's when they hit the panic button, shut everything down and got the hell out of there."

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"We were warned," I said without sympathy. "Everyone ridiculed Wilson when he told us to ease up on things, keep the energies down and the beam profiles tight until we got to the inflation era—that if we pushed it too far we could start another inflation of a spacetime already stretched to the limit. And you're telling me they might even have produced the Higgs, for Christ's sake! The God particle, from whence cometh mass! Why didn't they just go all the way and start the big bang all over again?"

Tom leaned close, his voice soft. "That's just the kind of thing I *don't* want you saying to John McClusky's mother. She won't understand it, and it will not comfort her. Please, Erv, just tell her what you *saw*. Anything more could be bad for all of us, including you."

"Is that a threat, Tom?"

Tom reached across the table and squeezed my hand. "We've known each other a long time, Erv. From me—it's a warning."

We finished our breakfast in stony silence.

Two mornings ago the day had begun wonderfully with sunshine and unseasonably high temperatures for a November day in Illinois. I'd left Ellen, and Tasha the cat, at eight and made the twenty-minute drive to University Park through what was left of the cornfields of the past. Big sky country in all directions, unlike the canyons of Chicago where I'd spent twenty years of my academic life. I'd transfered to University Park because that's where all the string and twistor theorists were these days, and where we were pushing back physics to the Planck era with the Bosax Supercollider. When I wasn't in class, I argued topologies and perturbation theory with my colleagues, and the guys in Building E kept cranking the energies higher and higher across the great desert between the W and Z bosons and the Big X particle that marked the point of grand unification of the strong and electroweak forces. All very exciting, and fun.

It's a lovely campus, wooded in maple and birch, the buildings of red brick, stone walkways lined with beds of pansies and petunias, and roses in mounds around the quad. The Bosax drift tube from Batavia's Tevatron injector to the north lies thirty meters underground, the southern tube coming from the new Tevatron finished in '37 some twenty miles to the south. That's where the big antiproton storage ring is. And on a clear day you can look east from the top of Feynman Hall and see the hundred-megawatt fusion reactor that powers the whole thing. Look down, south, and there's Building E, the collision area—little more than a stone's throw away from you—where protons and antiprotons come together with the energy of the big bang—the beginning of everything. Or the end.

I'd just reached the quad that morning when John McCluskey intercepted me. "Doctor Morgan! Can I talk to you a minute?"

I turned around and saw him trotting smoothly toward me—the scholar-athelete, short-cropped hair, square jaw, and friendly smile as always. A body big enough to fill doorways. He stopped beside me and touched my shoulder warmly. "Morning," he said.

John was a-toucher. Even the ladies accepted it, for with John it was a totally unthreatening gesture, lending a kind of intimacy to conversation with him. He was liked by everyone.

"I've been meaning to ask you a question I brought up in class, but you got off on something else and didn't get back to it," said John.

"Oh, oh," I said. "I'm sure it isn't the first time I've done that."

John laughed. "No problem. You were talking about the nucleosynthesis era, and I asked you where all the antiprotons went. Remember?"

It came back to me immediately. "I

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said there was a slight excess of protons over antiprotons, so some protons survived annihilation and that's why we don't seem to have any naturally occuring antimatter in the universe."

"But why an excess of protons?"

"It's high energy physics, John—a slight breaking of something called CP symmetry. There's a really big particle responsible for it, but we haven't found the particle yet."

"So it's still a theory," he said.

"Until we find that particle, it is. We go a step at a time, John. That's science."

Another touch, then a pat on the back. "That's okay, Doctor Morgan. You guys will find it someday. Thanks. And I'll see you in class."

"You bet," I said, and he rushed away. The class he referred to was Astronomy 110, my annual contribution to the general education requirements in science, and a refreshing change from the specialized theoretical seminars for budding young egotists I teach each quarter.

I went on to my office, quickly forgot our brief conversation and at noon entered Bohr Auditorium—a two hundred seat, seven tier affair with soft lights, indirect sunlight from high windows along the south wall, sliding boards and an overhead projector screen fit for Imax. Sixty students were physically present, perhaps twenty mentally so. The powers that schedule noon classes deserve eternal suffering. At noon, half the students haven't eaten. They are hungry, resentful, and not receptive to learning. The other half, with stomachs full of fast food from the student union, have by now entered a catatonic state which cannot be reversed by any known process. So I taught to perhaps twenty, and wished the others well.

John was there in the fourth row, bright-eyed and alert. Next to him was Val Tenisson, a slim, pretty, but terribly intense young woman. The two of them together accounted for ninety percent of the questions asked in class, and my needs are simple. They'd slowed me down nicely the week before when we were talking about the Big Bang: the Planck era, expansion era, evidence for the condensing out of dark matter, a kind of parallel universe connected to us only by gravity. Of course such a universe would differ from ours in detail by quite a bit, given the infinity of evolutionary pathways, I'd said. Theory, of course.

The subject of the day was the possibility of extraterrestrial life, and I was feeling clever. I had a transparency of an old Finley painting of a classic "bug-eyed monster." I slapped it on the overhead projector, and turned it on. The class giggled, even the catatonic. "Now why," I said, "would such a creature want our women?"

Laughter. I had them, at least for a moment. I plunged into a summary of all factors necessary to produce life on other worlds.

I got about ten minutes into it. Then, at twelve-ten on a sunny day, the universe as we understood it suddenly changed.

It was as if I'd had a sudden lapse of consciousness, a fogout of vision for just an instant. I stopped in mid-sentence, my train of thought gone, and I was embarrassed by it. This sort of thing does happen to me more than occasionally, but only when my mind is going in several directions at once. I heard movement in the chairs behind me, but otherwise there was silence in the room. I turned and looked at the students, their faces frozen in a sort of surprise. "Whoa," I said. "I think I drifted off there for a second. Let's try it again."

The students looked at each other. Nobody snickered.

"The secret to life is liquid water, and each type of star has a definite zone over which this is possible. Let's start with our own sun." I took out a transparancy, placed it on the projector and started to focus it.

The lights in the room seemed suddenly to brighten. The sunlight stream-

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ing through the high windows disappeared, leaving blackness beyond the glass. Before me, the room boiled, images of students, chairs, the walls, the high ceiling above us, everything shimmering, shifting, and for an instant there weren't sixty students in the room, but many more, the room now expanded to tiers rising half way up the wall at the rear of the auditorium, tiers filled with students—all of it in black and white, no colors. Sweat broke out on my forehead, and I thought I was having some kind of stroke.

But it wasn't just me; my students had seen it too. "What's going on?" asked a young woman in fifth row, looking frightened. "Why is the room moving around?"

"Who are those people?" asked another. Notebooks slapped shut, chairs squeaked, and several students started to stand up, ready to bolt for the exits.

"No, stay here!" I shouted. "I don't know what's going on, but stay in your seats!"

They sat down on the edges of their seats, ready to sprint. My heart was pounding, knees shaking, and I took a deep breath, exhaling slowly as I turned off the projector. "Stay calm, everyone. Let's try to figure this out."

I'd not yet made the connection with Building E, and the beam pulses thirty seconds apart. But the third, and thank God the last, pulse hit then, and suddenly the room boiled in soundless bubbles of shimmering opacity. The air was still, yet there were images of shadow students coming and going in various parts of the room, images settling into a uniform intensity showing row upon row of them crossing our own seats at a shallow angle up towards my left. Shadow students, dressed uniformly in slacks and high-necked tunics, about the age of those in my own class. And they had seen us, too. Shadow students arose and scrambled to my right, some initially sitting practically in the laps of my kids, others running right through them to get away.

My own students freaked at that instant, scrambled towards my left, banging into each other. "Stay in your seats!" I bellowed. "Don't leave the room! We don't know what's going on outside, and it could be dangerous! Keep your heads!" I left the podium, walked up the aisle to shoo them back into their seats, and it was then that John McCluskey said one simple thing that seemed to stop the panic.

"Doctor Morgan, if this is a shadow universe you were talking about, then it sure seems to be pretty parallel to ours. We have two professors in the room, now."

Two professors?

I was halfway up the aisle, and looked back to the front of the auditorium. Standing only four steps to the left of my projector was a tall, gaunt figure dressed in slacks and a shirt with puffy sleeves and frilled collar. Behind him hovered lines of runelike script on what must have been a white board, intersecting my own scribblings behind the projector. He smiled at me, and waved.

I waved back, and walked towards him, patting John on the shoulder as I passed. "So much for theory, John. Let's see if we can say hello."

There couldn't have been a better chance to keep the students from panic, and I grabbed it. "Whatever has happened here, it can't last for long, so let's learn what we can while we have the opportunity. All of you start copying that script as best you can. We'll try to put it all together later." I walked up to my board, nodded at my shadow colleague, and wrote out the alphabet in large block letters as quickly as I could, then my name, Erwin, below it. Pointed to my name, then myself. He nodded, understanding immediately, then faded from view in a shimmering bubble. A second later he was back, scribbling a line of runes, then four symbols below it, pointing to himself. "Someone get this down," I said.

My students were now writing furi-

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ously, fear and panic momentarily forgotten, heads down, and well it was so, for around them the room still shimmered and shifted, shadow images appearing and disappearing in bubbles of varying opacity. Definitely not a stable situation, and I was feeling a horrible urgency about what we were doing. My colleague was speaking to his class, and they were also scribbling on flat boxes in their laps while sneaking furtive glances at my students doing the same. "Let's hope he doesn't have a history class or accounting majors over there," I said in a feeble attempt at humor. I wrote 'H' and 'He' on the board, and underneath drew in the nuclei, protons and neutrons labeled, the electrons circling in orbits around them. The shadow professor grinned, and clapped his hands. He raised his stylus and in rapid succession drew a coil, then a prism with a light ray refracting through it, then an inclined plane with a block sliding on it. He pointed to his class, and smiled again.

"I think it's a physics class," I said.

"Super-parallel, Doctor Morgan. Boy, were you wrong," said John McClusky.

"Just get it all down," I growled. I drew a coil, an arrow to indicate a current, then lines to show the magnetic field produced. I used conventional current, and now wish I hadn't done that. It just confused things. But my colleague nodded, held up a hand as if to tell me to wait, then turned and walked *into* my board, disappearing in a roiling mess of space-time. It was then that Don Severson, who taught a calculus physics class down the hall from mine, appeared at one exit door and motioned frantically to me. "Erv, you've got to see this. It'll only take a minute."

"I can't leave my class, now," I said.

"One minute. You've got to see what's going on outside."

Curiosity overwhelmed common sense, and I lost valuable time with my shadow colleague, time that could have made a difference. "All right. Everyone stay put. I'll be back in a minute or two." I bounded up the stairs and met Don at the exit. He took my arm and hurried me along the hallway. Shadow students descending a staircase jumped back from our passage, others milling around in a hallway beneath our feet. We went to the bridge between the two wings of the building and looked out. Buildings flickered upwards from the quad, and there was a street directly in front of us, an off ramp from a freeway filled with little bullet-shaped cars whizzing diagonally across campus. Another off-ramp passed directly through Building E, and there was an accident—a massive pile-up there. Shimmering shadows again, but more stable around Building E. The sky was dark, and beyond the campus, perhaps for a mile, there was nothingness except for a faintly glowing orb about twenty degrees up from the southern horizon.

"Isn't this the most incredible thing you've ever seen?" Don asked. "And see how the images are clearest around Building E? A few minutes ago, everyone in the building ran outside."

People were pressed up against the walls of the building, not moving. Images further from the building were clearly starting to break up, and even the sun flickered once, sending out one burst of bright light. "I have to get back to my class," I said. I was thinking of my wife and cat, and whether I'd ever see them again under that faint sun.

"Me, too," said Don. "Suddenly we had a hallway running right through the classroom, and shadow kids running like hell to get away from us. My students are less than calm, and I've got them standing up against the walls with two football players guarding the exits."

"It's centered on Building E," I said. "That has to be the source of it all."

"The X boson experiment? You think *we* did this?"

More shadow students scattered in our wake. "Has to be. And it's starting to

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break up again." I hurried my pace, while around me the images of another universe shimmered and roiled.

But things were relatively quiet in the auditorium, and my colleague awaited me. The students had begun questioning each other while I was gone, holding up pictures and diagrams to show each other. Only later did I discover how far their questions strayed from the boundaries of astronomy and physics.

Professor Shadow held up two metal bars, brought them together and they stuck to each other. Bar magnets. He gestured the direction of the magnetic field, pointed back to the coil he'd drawn. Yes, currents cause the field. He pointed to his board, a diagram drawn there, the parts labeled with runes.

"He drew that while you were gone," said Val. "It looks like a hydrogen atom."

Indeed it did. I pointed to the electron, went to my board and drew magnetic field lines, then a wiggling line for a photon coming in to produce a positron-electron pair. I used the right-hand force rule for the positron, the left for the electron, showing the force directions, the curving paths of the particles, labeling them both. He looked at the drawing, nodding slowly, but I sensed some confusion and then his image boiled in a shimmering cloud. Around the room, images of his students were roiling, the upper tiers of them disappearing for several seconds, and our south wall was a mess of flickering colors and shapes. Whatever instability it was I'd seen outside had now reached our building, and was inside. My sense of urgency increased in one great leap.

He was back again, and had reproduced my drawing of pair production, was gesturing with his hands, thumb pointing in the direction of the particle paths, fingers curling clockwise or counter-clockwise as he switched hands. He pointed to one particle, then back to his drawing of what had to be hydrogen, tapped the rune for the electron and gave me a questioning look.

His image roiled again, and I heard scuffling sounds behind me. My students were out of their seats, moving away from a wall of flickering color progressing across the room. Whatever it was, the shadow students had seen it too and were moving in the same direction. "Doctor Morgan, we've got to get out of here!" said someone.

"Get up against the wall, then. I can see the whole room from here, and whatever that mess is it's leaving the seats intact behind it. If you panic, you could hurt yourselves getting out of here!"

They moved clear to the wall, pressing up against it, the shadow students only steps from them, huddled together among the seats and afraid to get any closer to what they undoubtedly perceived as shadows in *their* universe.

My colleague appeared briefly only one more time, and he was tapping his drawings of pair production and then the little atom, looking concerned and saying something over his shoulder. His students were inching away from mine. Something was wrong; I knew it at a subconscious level, but for the moment couldn't call it up. Just a few seconds more would have made the difference. Just a few *seconds*!

It's something I'll have to live with.

The roiling mess moving slowly across the auditorium was becoming a pyrotechnic display, breaking into bubbles with points of colorful light flashing from within. I felt a hand on my shoulder, pulling me backwards. It was John. "We've got to get out of here. People are ready to run!" he said.

"All right! Move to the exit in single file, but stay calm! When you get to the door, move left down the hall and take the stairs down. No stampeding!"

The kids moved without hesitation, except for Val Tenisson, who waited for John and me to catch up. John pulled on me as I stared at the empty space where my colleague and his runes had been, my mind whirling. Pointing with

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thumb, curling his fingers like that, it was no force law, but—

"Let's go," said John, grabbing my arm. I shook him off. "Right behind you," I said.

John started up the aisle, and then it hit me.

Helicity.

Shadow students were pouring through mine, escaping through some exit to my left, but one young woman was overtaken by a fiery bubble and was in panic, mouth open in a silent scream, arms flailing. I saw my colleague, appearing out of another bubble behind her and reaching out to pull her back, three seats from our exit aisle. John saw their struggle, hesitated, moved a step towards them.

Helicity. A constant property of a particle regardless of the universe you live in. God is left-handed, they say. My mind jumped between the two drawings I'd seen, and came to a horrible conclusion, but too late.

John lunged towards the struggling young woman, reaching out a hand to help her. Val lunged behind him, got one hand on his back before he slipped away from her.

"*Don't touch her!*" I screamed.

John's hand plunged into the flashing bubble, and became a shadow, then his arm, his shoulder. The girl's eyes went wide with fright and she started to pull away, but too slowly. John went after her and was now a shadow to us.

He touched her.

Val screamed.

I screamed.

The roiling mess in the room disappeared, and sunlight was streaming through the windows above us.

The shadows were gone.

And so was John McClusky.

We stood there for a few seconds, and the silence was absolute. I was holding my breath, waiting for something more, but there was nothing.

Val broke the silence. "John," she said, then burst into tears.

* * *

So, how much of this do I say to John's mother?

That was my question for Tom Hadley after we'd ended our long silence over breakfast. I apologized for being crabby; my sleep the night before had been brief, my mind on too many things. I'd thought about what I would say to John's mother, of course, wondering what could be said to comfort her. He was a wonderful kid, the ideal student-athlete, et cetera. But my mind was also a whirl of physics: supersymmetries, gravitinos and photinos, the great expansion with its myriad bubble universes expanding forever away from each other, yet in each bubble two universes bound together only by gravity, separated by a barrier at the very beginning in order to prevent their mutual annihilation.

John had found his missing antiprotons.

My noon class was attended by only thirty or so, and Val Tenisson was one of those missing. My lecture was dull, without feeling or enthusiasm, but I wasn't even angry with myself about it. In fact, I wasn't feeling anything.

But as I crossed the quad to get a quick lunch before my meeting with John's mother, I had some disquieting thoughts that won't go away. The energy release in a roughly one-hundred-kilogram total annihilation event is enough to make even a military person think twice, and we can only be selfishly thankful that John had penetrated to the other side when it happened. Here, the sun was warm, and I was crossing green lawns bordered by colorful flowers under a blue sky, students stretched out on the grass to catch some rays, and a shadow world there too, unseen by us, yet murderously marked by us.

John is gone, and we grieve him. But what of the shadow universe in which his loss was most keenly felt?

What have we done to all those poor souls on the other side? ■

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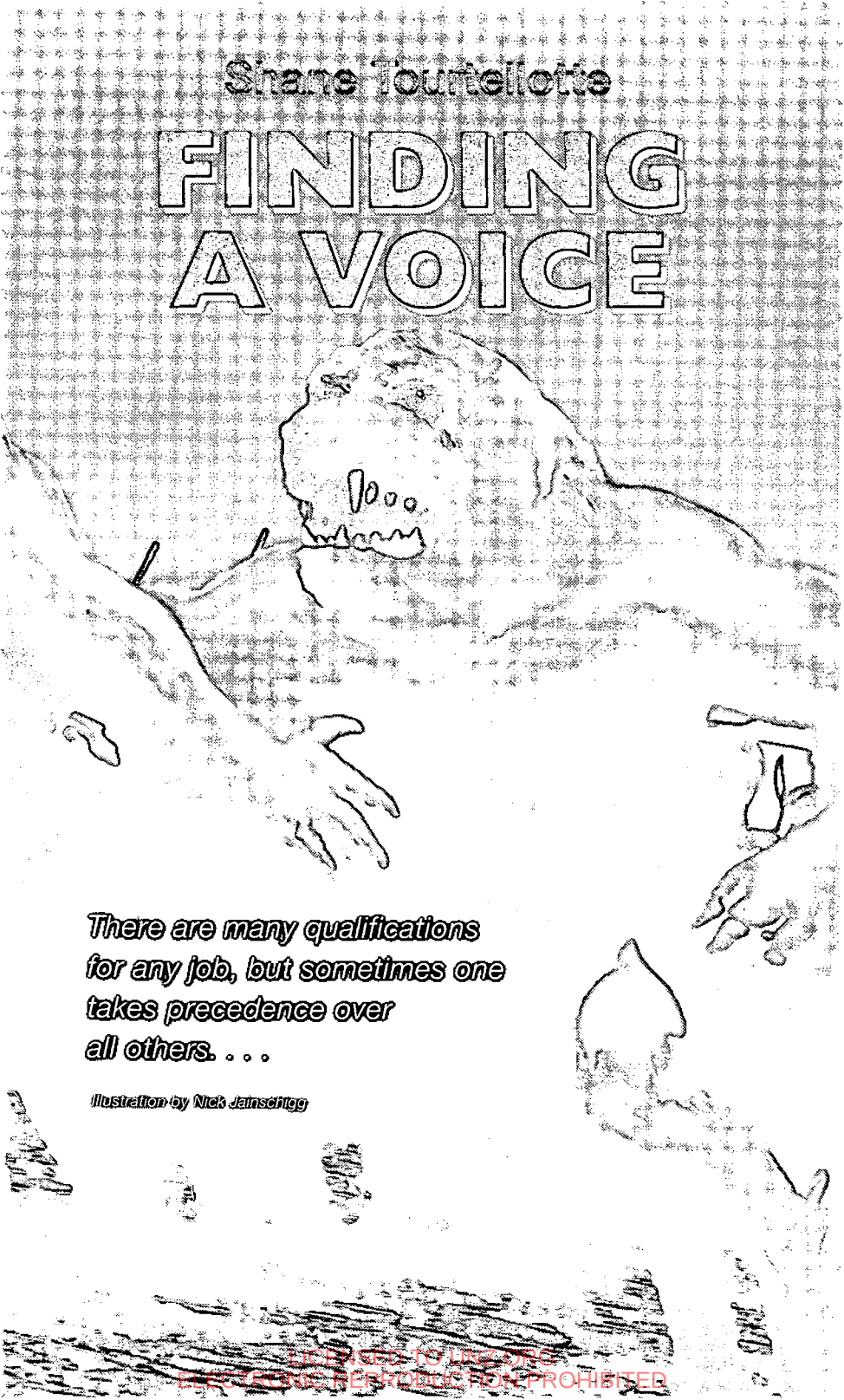
Shane Tourtellotte

FINDING A VOICE



There are many qualifications for any job, but sometimes one takes precedence over all others. . . .

Illustration by Nick Jainschigg

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"Welcome aboard the *Cortelyou*." The woman at the portal thrust out a welcoming hand. "I'm Noemi Reyes, executive officer."

The new technician shifted her baggage to take the hand. "Li Qing, your new techni—sorry, you must know that already." She felt a swift study pass over her from Reyes's eyes. "Glad to be aboard."

Reyes nodded. "Let's get you to quarters before you drop something."

They entered a lift which took them up two decks. They emerged at the head of a corridor with doors down both sides, and a heavy double set at the far end.

"I know you've met Zheng Zifei," Reyes said. "He approved readily of your hiring, and I know he never approves anyone without meeting them."

"Neither must Captain Vehra. I expected a telepresent interview, but he flew into Taipei to follow up my application. He takes great pains selecting his crew."

Reyes put on a stiff smile. "You can say that." She opened Li's berth, first door on the left. "Everything here should be pretty intuitive. If you need help settling in, ask me. Crew relations are my province."

"Looks fine." She laid her gear by the bed. "Besides, I can ask the computer anything, can't I?"

"You certainly can," said a gentle masculine voice, apparently from all around.

"I was wondering if I would have to introduce you," Reyes said archly.

"I simply awaited a conversational opening. Welcome aboard, Miss Li. I am the *G. B. Cortelyou*. Please call me George. I understand you shall be working with me."

While Li replied with conversational mundanities, Reyes realized with a jolt that she was holding the door open. She moved aside to let it close, sighed, then gave a brief, anxious glance to one of the internal bulkheads.

". . . three years experience with synthetic intelligence. Is that sufficient?"

"Ample. My trust in your professional abilities is implicit."

Reyes approached Li. "Can I show you to the engine room? Kayah Mon's there. She's the other tech aboard."

"All right." On the verge of leaving, Li instead shifted her baggage to the top of her dresser. Reyes's foot twitched. "I will be able to board here until we depart, right?"

"Sure. I hope you don't stay tucked in your quarters. Bern has such a vibrant culture, with all the alien representations. You should sample some."

"I will." She finally headed through the door, and Reyes began relaxing. "I want to see some Shapers' automutating biosculptures, but I should probably put that off. There's a recital tonight, humans performing Tutresh prose-chants."

They had started toward the back portal when the door of the quarters next door shushed open. "Putrid stuff. Save your ears."

Li turned in alarm—Reyes in frustration. The speaker slouched against one edge of his door, looking them over with weary contempt. He stood half a head too tall for his build, and his face was a disheveled, horsy fright, obviously never genetically adjusted, unless to accentuate the ugliness. One trouser leg rode up his bony shin, and his huge bare feet splayed across the deck.

Reyes stepped in quickly, hoping to cover the full nature of the affront. "Li Qing, this is our intermedia officer, Oswald Pitt. We were just going to settle her in, so if you'll—"

"How did you know what we were discussing?" Li exclaimed. Reyes's shoulders fell: nice try. "Were you eavesdropping? How?"

"Remember my title. Figure it out." He glanced up, apparently paying attention to her for the first time. "Captain's ordered Chinese, I see."

Li reeled as if struck. "Pitt!" Reyes bellowed.

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"You wait. He'll be growing epicanthuses." He squeezed between them and the bulkhead. "I'll be on the bridge, ma'am."

Li watched him in shock until the lift door closed. "Now that that's out of the way," Reyes observed, "everything else will be looking up."

"He's not new, is he?" Li asked, knowing. "How long have you put up with that?"

"Since before I signed on, and that was four years. Captain says he's too good to let go."

"Good at what? He's intolerable! How can he listen to people that way?" Answering the question herself, she looked up. "George, why do you allow that?"

"Regulations grant an intermedia officer audio-visual access to public areas. The corridors qualify, among other places. Quarters do not. It is a safety measure, not subject to discretionary countermand."

Li still fumed. "Do you need an intermedia officer, a human one? Are there regulations for that?"

Reyes smirked. "The same regulations that require three engineering and technical officers for a light freighter." Li went silent at that, to her relief. She worried Li might suggest she double up, and she did enough of that already.

"When do we lift off?" Li finally asked, as they started toward the engine room again.

"Captain Vehra's closeted with his 'contacts'," Reyes said. "He never tells me anything about this, but he always gets us work. Should be soon."

She got the call the next day. Ashok Vehra, *Cortelyou*'s owner and captain, downloaded the manifest indices to her, told her this was a big assignment, and asked her to supervise loading with Popescu. He didn't say why the assignment was so important, and the listing of organic computers didn't help much.

Reyes couldn't help noticing the tintstrip Vehra wore across his eyes, and his distracting blinking. And was his skin lighter, maybe taking on a pale hint of saffron?

She silently cursed Oswald Pitt all through loading. Michael Popescu noted her frozen scowl without comment. He wore something similar, the face he always put on when expected to work. Duties as manifest officer were heavy on the short occasions when needed, an imposition he seemingly resented as infringing on his right to free pay.

Reyes shook her head clear. She wasn't mad at Michael—not even at Oswald, or no more than usual. He was just his most infuriating when he was right.

Crew relations were smoothest with the stability of intimate relationships introduced. The presumed general contentment of the crew took precedence over worries about power relationships and exploitation. So went the captain's theory, a popular one.

Kayah Mon was close with the head engineer, Zheng Zifei; they might even have quietly married. As for Reyes, she had an understanding with Michael. Neither would say they weren't involved, and others could draw the conclusions they liked. It kept Vehra's attention diverted. Good news for her; for Li Qing—well, she was left standing in the current round of musical chairs. She'd have no excuse.

Oswald, of course, didn't count. That was a given.

"I have the courses set, George. Care to bet which one Captain Vehra will pick?" A braying snort came across the bridge. Reyes ignored Oswald with the ease of long experience.

"You're being facetious to cover your conclusion. Why not prepare one course only?"

"Because I like to do the job right, even if it won't matter. Call it pride."

"As you wish. Captain Vehra has just come aboard."

Reyes sat up. "Relay my request that he come straight to the bridge."

"He is already en route."

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A moment later, Vehra appeared at the doorway. Reyes noticed a couple more kilos around a midsection draped in latest fashions. Oswald glanced briefly at his eyes, and broke into a taunting grin. The captain missed any significance.

"Oswald, contact flight control to get us a launch window. Anytime today will do."

"Already done," he replied, rolling his eyes. "We have standing clearance."

Vehra hid a slight consternation. "Very well. Noemi, input an FTL course to Tutresh."

Noemi calmly scrolled two columns of figures across her monitors, plainly enough so he might notice. "Any special plotting, Captain? Avoidance of high-traffic lanes?"

His expression shaded into the peevish. "None. Straight course, thank you. I'll be in the back areas, seeing how our new crewmember is fitting in. Inform me when we're ready to launch."

"We are ready now, sir." She paused a moment as he froze midway to the door. "Shall I hold our launch?"

She held his gaze, knowing he wouldn't appreciate the mocking faces Oswald was making. "No," he finally said. "Give me two minutes to prepare in my quarters, then lift us."

"Yes, Captain. George, announce to the crew: two minutes to launch." She could hear the announcement begin outside, just before the door closed behind the departing captain. A low, cackling laugh came from the other side of the bridge. Soon he began humming a strange, jerky set of notes, not really music, until the stresses of liftoff pushed it out of his throat.

All went smoothly through intermediate-orbit insertion. Reyes gave George control of the transition to tachyon drive, which he handled best anyway, and hurriedly left the bridge. She caught Vehra at the threshold of the captain's quarters, in something closer to standard uniform.

"I thought we could discuss our current employment, Captain."

Vehra sagged in frustration. "Must we discuss this now?"

"Why not now?"

His expression soon shifted to gratification, as she thought it would. He did love expounding on his little coups in his political circles, the connections he forged, and the chits he called in. "Well, I imagine you're surprised we're involved with the Tutresh."

Reyes wasn't—she had gleaned that much from newsfiles, charting his appearances at gatherings and functions—but it was unusual. "Have they retained us?"

"No, no, it's a government contract, but so very important. You see—" He waved her inside, as if the wrong people could overhear. "—we're trading for their exploratory data. Not just the trading corridor. All of it."

Reyes was stunned silent. This was actually as important as he made it out. The Tutresh and Kron domains hemmed in Earth's expansion, locked Aamahh and the Shapers into their own uncomfortably small pocket, and dominated the politics of the five spacefaring species. If Terrans could leapfrog their limited exploration bubble, spread their colonies without long appraisals of candidate worlds, it would boost human political muscle immensely.

There almost *had to* be a catch—and there was. "They're getting our bioprocessor technology in return," Noemi deduced. "They've been after that for—ages."

"I know. They've hit the limit with electronics. They're desperate. We could finally name our price, and we did." Vehra bounced heavily on his soles. "In return, they get a few dozen advanced devices, specifications, all the technical data."

"Bern could have sent specs and data by tachyon pulse."

"The Tutresh don't trust tachyon pulses. Too easy to intercept. They want

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tight control, and since we're getting paid for their desires, I don't see any problem," he concluded with a bubbly giggle.

Reyes thought about the payment, and her nagging qualms faded. "The crew should be very glad to hear this, Captain."

"Go ahead and inform them, then. Excuse me, I'm late for something." He hastily left her behind in his rooms, her new petty duty resting on her shoulders. Considering the upside, not a bad trade.

Tutresh was a month away at cruising speed, a long stretch in a small ship. Reyes made it her stated priority to assure Li of settling in well. Her unstated priority might be tougher.

Li had little trouble with work. Zheng assigned her to the computer center, giving her primary responsibility for keeping George in optimal condition. They gained a quick rapport, Li learning how to listen to his minor complaints, George judging how best to express them to her.

Relations with the crew developed apace. She formed a strong working relationship with her technical colleagues, quickly got on Michael's good side, and had a virtual guardian angel in Noemi—the familiar basis coming within days.

There were two natural exceptions to the general rapport. Captain Vehra was, among other things, the captain. He liked his rank, even if he did prefer the perquisites to the functions. He kept at a remove, in professional matters.

Oswald Pitt was the second, unambiguous exception. He gladly stayed apart at most times, a policy the crew objected to only when broken. Noemi took it upon herself to explain him, as far as she could. She told Li Qing he wasn't as bad as his first impression in some ways—and in others he was worse.

"His hygiene is—intermittent," Michael said around a mouthful of food. "You might have noticed already."

Li made a noncommittal gesture. There were five crewmembers in the mess room. The two exceptions were predictable: Vehra dined alone, while Oswald's hours didn't mesh with the rest.

"He'll be all right for a while," Michael continued, "and then he'll forget a couple days, or maybe he decides he hasn't been offensive enough lately."

Li smiled involuntarily at his observation. Her eyes kept pulling toward the ceiling. Noemi assured her he didn't listen often, that her first-day experience likely sprang from initial curiosity. The assurance did not give her ease.

"Worried about him?" said Michael. "Don't be. He knows what we think, and personally I'm glad he knows. Hear that, Oswald? You're smelly, inconsiderate, and irritating, and you look like a randomly chosen end of a Clydesdale." Reyes gave him a stern look, but her heart wasn't in it.

Dinner soon turned quieter. Li received a computer pad to review from Zheng and Mon, who were working through the meal. They had their own pads, linked to them through plugs in the median nerves of one wrist each. The other plugs linked the engineers themselves, their hands clasped tightly, the first outward level of an intimacy that stretched the concept to its limit.

Silent work, silent contemplation, and silent eating lasted long enough for the interruption to jar them all. Oswald entered, loudly blowing his nose into a sullied tissue. Zheng and Mon glanced over as one. Other reactions were more tangible.

"Well, it doesn't sicken *him*," Michael said, "so why would anyone else find it disgusting?"

Oswald popped a nondescript ration box into the warmer. "Discussing your sex life in public again?"

Li watched Michael snarl some vulgar epithets in reply. Pure slander? Ring of truth? She vowed not to inquire, guessing she would learn in time despite herself.

"Don't make such rash assumptions,"

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Oswald retorted to Michael's last comment. "I just don't want to break up such happy couples. Take the lovely Z and M. The perfect honeymooning pair. There, see, another intimate moment. Doesn't last long when you're downloading at three gigs a second, but it's the closeness that really matters."

Zheng spoke in low, detached tones. "We'll thank you to let our personal lives alone."

"Uh-oh, speaking for the missus. She'll download him a chewing-out." He stopped, noticing the exaggerated sniffing Michael was making, and the searching motions of his head. "Using your nose, Michael? Good. Where both hands and a methane detector failed, that might just succeed."

Michael responded with a derisive exhale. Oswald smirked. "More like—" He gave a deep and startlingly equine snort, and savored Michael's reaction. "Or in your case, *baa-a-a-ah*."

"Why?" Li found herself asking. Reyes tried ineffectively to forestall her. "Why do you hate everybody, Mister Pitt?"

Oswald turned. "But I don't hate everybody." His voice had moderated, but now regained its sardonic edge. "Haven't met everybody yet." The warmer chimed, and he went to retrieve his dinner.

"Something you should know, in case you haven't learned already. He makes noises. Little sharp ones, like a *gruhokk*, or maybe a laryngitic seal . . ."

Li stood up. "I'm going back to my quarters," she told Reyes.

". . . not discreet at all. Stay there." He had his box and a cup. "I'm the one leaving." She remained standing, staring at him with a heat matched by all the others. He halted midway to the door.

"Let me fill out whatever they've told you about me. I ridicule people, because people are ridiculous. I don't care about my looks, because I'm used to them, and I don't care what others think. My habits suit me; other people don't . . ." His speech acquired a singsong cadence. ". . . and I'll go to the grave as an angry old man." On that peroration, he loped away.

Li dropped hard to her seat. "Was he quoting something, that last part?"

Reyes shrugged. "He does that sometimes. Some kind of poetry. It's like the notes he hums: they mean nothing."

"It's the voices in his head," Michael countered, "running out his mouth."

Reyes's mouth lifted into a weary, ironic grimace. "As good an explanation as any."

Oswald was shouting, more incoherently than usual. Reyes couldn't make him out. The sounds weren't human, or even animal.

Then the overhead struck her in the face.

She awoke pressed to the ceiling, klaxons blaring. The ship lurched, precipitating her back down, where the edge of her bed deflected the fall. She shouted for light. The room stayed black for a nightmarish moment, then began glowing a most inauspicious blood-red.

"All crew to stations! Disaster alert! Miss Reyes, are you injured?"

"No, George," she lied, gasping through the pain in her chest. She staggered through her door, down the hall a dozen paces, and into the bridge. Oswald was already there, an arm wrapped around his chair.

". . . engines are in critical imbalance, cause unknown. Repeat, freighter *Cortelyou* in distress. Stop interfering, George! I'm handling it! Go do something where you're needed." The ship bucked, nearly toppling Oswald, chair and all. "Like steering!"

Thus stung, Reyes went to the helm station. The pitching proved beyond her control, but it was stabilizing slowly. She risked the attention lapse to glance at the engineer's station. The area flashing the most red was condensate flow. The horror set in immediately. Their catalyst was dissipating, and when it was gone, so was their FTL capability.

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Captain Vehra reeled in, covering half his face with a small pillow. "What happened?"

An intercom call from Zheng blocked any reply. "Bridge, I am diverting all condensate circulation to engines, under emergency authority."

"What? No!" Oswald almost leaped from his seat. "I need that for communications. You have no right!" But Zheng did, and the message scrolls on Oswald's boards stopped and dimmed. He shrieked, and Reyes had a disorienting flashback to her nightmare of scant minutes before.

Vehra approached her. "Noemi, I'm hurt. Can you take care of this?"

Reyes waved him away, not even looking at what was under the pillow. She had starcharts before her, cross-references flying off her fingertips, and the hope that it might make a difference. Peripherally, she realized the shaking had stopped. So much the—there!

The *Cortelyou* seemed to tilt under her course change, but the sensation passed. It got her worrying about automatic compensations. "Li, is George still functioning properly?"

"I am," George himself replied.

"Concur," a harried Li called over the intercom. "No damage from the imbalance."

"Bridge," Zheng called, sounding exhausted. "Our condition is stabilized, but we are still slowly losing condensate. We cannot reach Tutresh."

"Can we reach here?" Reyes downloaded some starchart numbers to the engine room.

A long pause followed. "Yes," he finally answered. "Reducing speed to maximize distance covered per unit condensate lost."

"Noemi, please."

Reyes took a breath, and turned to examine the captain's injuries. Vehra revealed his face, marred by two long but shallow cuts on his cheek and jaw. She released her breath in a quiet hiss.

"Let me get the medkit. Oh, and we need to have a crisis meeting. People should have five minutes to secure their duty stations, then we brainstorm on what's happened, and what happens next."

"Good suggestion. Attention, crew," he said, knowing George would broadcast his voice. "Meeting on the bridge in five minutes. Finish your work and get up here. That is all." He watched Reyes departing to find a medkit, eyes wide and moist, hand resting on his wounded face. "Hurry."

A patch covered Vehra's cheek, and superficial relief graced his face. "Let's get started, people. Miss Mon, what went wrong down there?"

Kayah Mon furrowed her brow. Zheng was still below, nursing their crippled engine. "It finally happened. A tachyon wake hit us, directly against our vector. Whatever ship it was must have passed less than a kilometer in real-space distance from us. We were fortunate we didn't collide."

"Come now, you can't be serious. The Tutresh have proven that theory flawed."

"I can provide you all the data. You can trust that and the professional determinations of your crew, or not."

Vehra flushed. "Let's—let's not get mired in theoretical details. What damage?"

"The surge destabilized our osmium condensate out of Bose-Einstein state, and shifted the free osmium back into real space. That reaction's still continuing, due to residual tachyon energy. Flushing that would require shutting down the engines, and I can't guarantee restarting them with our depleted condensate supply."

"Is there extra osmium on board?" Reyes asked.

Michael Popescu shook his head. "Not even traces. Tachyon systems use them all."

"Which means we need to collect more," Mon added, "or someone has to come get us."

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"Forget that," said Oswald. "Thanks to your debatably better half, nobody knows we need the help, and nobody will."

Mon flared. "You didn't even send distress signals?"

"I sent them fine—half a dozen of them—but I got cut off before I could tell anybody what was wrong! All they'll hear is a distress call, and silence. They'll think we were destroyed, and no one will come looking, except maybe for scrap."

"Well, we can stop here and divert condensate, so you can send further messages. Someone will come for us. If we can restart engines afterward, so much better our luck. With your permission, Captain, we'll—"

"No, Kayah." A quaver shook his obduracy. "Our mission can't end in such ignominy. It—it would endanger the compact. Yes. Find another way, Technician. Get us back on course."

"May I remind the captain, any delay in stopping to send distress calls will diminish our chances of engine restart very rapidly to nil." Silence met Mon. "Very well. We will then have to restock in the star system ahead."

Reyes took over, summoning a tridimensional chart. "We didn't have many options. This was the closest system with planets." She highlighted a yellow-white star, its designation a long alphanumeric string. "We'll reach it in nineteen days at reduced speed, right under the wire. George can give you details, and I gather from him it's not the best news."

"Judge for yourselves," said George, his accustomed calm self. "Kuess is the second of four planets. The designation is Tutresh: they explored this world some decades past, and we have the data through an early navigation treaty. Kuess is not only habitable, but inhabited by an indigenous sentient species."

"Uh-oh," said Michael. "What protections have the Tutresh given them?"

"Interdiction Major. No contact save in emergency, no resource use without compensation to natives, no introduction of technology."

"That only covers trading or giving technology," Reyes added. "We can still use it ourselves, though Interdiction Code expects certain discretion."

"Miss Reyes, there is a problem with that. The Kihoa themselves—" He spoke their name in three high, descending tones. "—reacted most adversely to any technology beyond their own level. Reasons are unclear: the Tutresh abandoned their surveys before satisfactorily answering that question. Discretion will allow no use of sophisticated technology including, unfortunately, translators."

"So we get to learn their language the hard way," Oswald cracked. "That is, if humans can speak it, and if we even know what it is."

"I have an incomplete lexicon on file for one regional language, the most the Tutresh could compile. As for human ability, that is another problem."

Michael swore under his breath. Oswald followed suit, stronger and louder.

"The Kihoa language is pitch-specific. The particular tone of a syllable determines its definition or inflection. The name Kihoa, translating to "all-inclusive people," shifts meaning if pronounced with different notes. It could become "secluded person," or "mob," or gibberish.

"Most humans exhibit only relative pitch recognition. You would miss the base language note altogether, or if guided to it, inevitably wander off it in extended conversation. Communication would be enormously difficult without artificial aid, unavailable to you."

A queasy silence followed, broken by Vehra. "Can't we alter our hearing, get this specific pitch you're talking about?"

"The genetic revision treatment for absolute pitch is no longer commercially available. You will not have it in your personal supplies. There is a rudimentary implant procedure, developed in the

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twenty-first century, but Miss Reyes hasn't the medical training to attempt it. No offense intended."

Silence fell again; Vehra broke it again. "We'll have to use translators. The natives will have to accept it. Better we offend them than the Tutresh."

"Sure," Oswald hooted. "The Tutresh can give us honored rites after the Kihoa slaughter us all. That should make—"

"Excuse me, Mister Pitt."

"What's your problem, George? I'm talking here."

"Could you repeat yourself? The latter portion."

He grunted. "I said the Kihoa are liable to murder us. What's so hard to understand?"

"My comprehension is unimpaired. Please step into the corridor for a moment."

Oswald stood defiantly, pushing back his chair. "I'm staying right here! I don't take orders from you!"

"You'll take them from me," Reyes said. "Step outside."

He turned his invectives her way. On a glance from her, Michael grabbed Oswald by the arms, dragged him to the door, and shoved him out. It closed automatically before he could recover, and briefly shuddered with arrhythmic thumps.

Michael slapped his hands together, as if brushing off dirt, and sat. "Not that I didn't enjoy it, but why did I just do that?"

"He's got it," Reyes replied before George could. "The ear, the pitch, whatever. Is that right?"

"I am currently endeavoring to test him. Considering his perfect rendering of the Kihoa name, it is most likely."

"You should test us all," said Li, speaking up for the first time.

"I am scanning my memories of all your speech patterns. The engineers have some such skills, but they are due to, and dependent upon, their neural computer links." He paused a hairbreadth of time. "I will test you all separately, but the probability of any of you having perfect pitch is vanishingly low. Excepting, that is, Mister Pitt."

This time, the silence didn't lift. They all sat contemplating, in various degrees of alarm or horror, until the bridge door slid open. Oswald came in like a sleepwalker, staring into nothingness.

"I thought he was kidding," he said to nobody particular. "I never thought it was anything special. I figured everyone heard like that, didn't even think about it." His eyes finally found Reyes. "I guess I'm drafted, huh?"

Reyes nodded tentatively. "I guess so."

A droning, ceaseless tone pervaded the room. Soft enough not to carry through bulkheads, it still had enough force to penetrate the one mind exposed to it. One voice mingled with it, hesitant but improving, now interrupted by another.

"Tell her to go away. *Mei-hho pin-e-tah* . . ."

"She informs me she will remain, and continue requesting ingress, indefinitely."

Oswald continued his exercises without answer, but the regular announcements from George finally broke him. "Fine! Let her in!"

Reyes winced as she passed the threshold, and not from the dishevelment of himself or his quarters. "What is that noise?"

"It's not noise, it's the Kihoa tonic note. It falls between the cracks of human scales, and I've gotta learn to think in theirs. Oh, but I suppose you don't know from scales. Too archaic."

"Maybe I don't." She advanced toward him, skirting a pile of clothes. "What's that?" she asked, spying a monitor teetering on a corner of his bed.

"Huh?" He lunged, shutting off the screen. "Those are just . . . call them study materials now. Mind your own business, would you?"

"That's the problem. You've told George not to inform us of your

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progress, and you're scarcely out of this room for us to ask you. Planetfall's in five days. We need to know if you're going to be prepared."

"Prepared?" He gawked in bewilderment. "George has been drilling me sixteen hours a day the last two weeks. I've been learning thousands of word-pieces a day. So help me, I'm *dreaming* in this language. So, do you think I'm prepared?"

Reyes didn't bat an eye. "I don't know. Are you?"

Oswald clutched at his frazzled hair. "How can—what do I—George, *tell her*!"

"Thank you. Mister Pitt's immersion learning is progressing faster than anticipated. His familiarity with pre-modern music is a significant aid in this, though it has inculcated unrelated scales which he must learn to disregard."

"Thanks for the biographical minutiae, George. Anyway, you heard it from him. Don't let my agreeing discredit him."

"I wasn't going to," Reyes said mildly. "Any specific problems?"

"Yeah, tell the engineers to stop meddling. Why should I be learning the word for 'platinum' when we need osmium, not that either word's in this lexicon."

Reyes glanced upward, for a better answer. "The language extends across two octaves," George said, "and Mister Pitt has problems with the high range."

"Did I say you could—? George, stop telling her."

Reyes took a step. "We can remedy that. A minor gene-revision and—"

"*Don't you dare!*"

She recoiled. "Would you prefer hormonal treatments?" She sidestepped a balled-fisted charge. "Forget it. Do it your way, but solve the problem." She scrambled to change the subject. "I've never heard you playing pre-modern music," she said, then realized how foolish saying that was.

Oswald caught her expression. "No, I don't do much of anything in the open." He settled back among his monitors. "You people'd be in sorry straits if you had to learn Kihoa based on modern noise. Phh, I'm lucky they use a twelve-semitone scale, or I'd never get anywhere."

"I'm—not following you."

"Not surprising. I didn't know all the nomenclature until busybody George gave me his tutorial." He threw up his hands. "Where to begin? Most pre-modern music has twelve notes in an octave. So does Kihoa speech, but it doesn't use heptatonic or whole-tone keys, doesn't need sharps or flats. . . ."

He looked up, and chuckled. "You look like you do when Zheng's spouting techno-nonsense: shut out of someone else's universe. You don't have to suffer through this."

"No, I'll suffer. I mean, I'm willing to hear you out."

Oswald took the surprise well. "Fine, take a seat—er, somewhere. I'll give you the five-minute lesson. Any longer, and George will kick you out and drag me back to school."

Reyes seated herself on a small bare patch on the deck. "Sounds tedious."

Something unaccustomed crossed over Oswald's face. "Oh, no. No." The moment passed, and his cynical self returned. "Okay, where to start undoing your lifetime of sewage feeding?"

"He's progressing, then," Captain Vehra said, unconsciously patting his healed cheek.

"Yes, sir. He has a surprising grasp of Kihoa linguistic theory, well over my head. Comes of familiarity with those old composers."

"I don't know about that. Obsolete triflers."

"Not so obsolete, actually. He listens to Mozart, for one, and I've heard modernized versions of his works."

Vehra wrinkled his nose. "He told you this, the unreachable Mister Pitt?"

"I saw the names on a file listing, for a

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second. Someone else's name I didn't quite catch, something like Billy Joe." She lifted her brows. "Country music?"

"Figures. He is an American."

"Regardless, he didn't bring them up." Reyes became pensive. "He did mention George Gershwin."

"Someone I should know?" Vehra intoned wryly.

"Nobody I know. Must mean something to Pitt, to bring him up. He said all composers were modern once, mentioned Gershwin for example—then he laughed and said, 'Poor George. He had no idea.'"

Vehra half-covered a yawn. "Are you certain Pitt is applying himself, not just indulging in antiquated hobbies?"

"George can vouch for him. I did manage to have Pitt permit him to give us progress reports. You can ask at your leisure."

"Yes, I'm sure I will. Meanwhile, the responsibility is yours to keep him under tight rein. I don't want his sporadic misanthropic behavior surfacing and sabotaging my negotiations."

Reyes folded her hands. "He'll need a little breathing room, some demonstration of faith. Obvious mistrust could trigger . . . misanthropy."

"Fine. Show him we trust him. And try to pick up some of this language yourself, in case he's just intractable." He stood up, cueing Reyes that they were finished. "I'm depending on you, Noemi."

She allowed herself a thin smile. "Yes, sir."

Yaru Ihham awoke to distant thunder. He rolled his head toward the window, and saw two dawns on the horizon. The dimmer one was already fading into the true sunrise.

He turned out of bed and began dressing slowly. Whatever it was, was over the near hills, five thousand paces distant. Instant response was impossible; poise was not.

His daughter began speaking outside the door. He reassured her before her faltering could go on long. She knew; the whole town must know, and others would soon.

A crowd was gathering outside his house, trading anxious conjectures. They were too agitated to pick a representative for their petition. They wanted to know something before they acted. So did he, but some action could not wait.

He went downstairs and opened the main door. The throng swelled toward him, cresting at a respectful distance. "Criers, call out the guardsmen. Have them gather at the armory and wait for orders. Are there guardsmen here?"

Before any could answer, a clamor reached the edge of the crowd. There were indistinct shouts, and suddenly someone tore into view, so pressed for speed he was on all fours. He skidded to a halt and stood, gasping. "Overlord, Tutresh!"

Yaru barked down the furor that followed. "Be sure of what you say."

"I am. Their ship awoke our hunting party—landed not a hundred paces away in the dry valley. We saw them emerge. They are coming here."

A cold wind passed through him. "I will face them. Guardsmen." Three had stepped forward at his earlier command. "You, report to barracks. Orders are to maintain civil peace. You will accompany me; you will trail us at a distance, to report back if necessary."

He began walking, acting before people's imaginations could conjure reasons why that guardsman would report back alone. They marched briskly, three paces a second, on the road toward the hills.

The overlord prepared his greeting, old teachings coming back to him. Tutresh gave offense easily, but were fundamentally passive, easily checked by strong displays. The danger they posed was small. Not zero, but small.

He spied their group three thousand paces ahead. Even with the light behind

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them, it was plain those four were no Tutresh. Thinner creatures, much like Kihoa, but still alien. They tottered on straight legs, barely supporting themselves. Their clothes hung more closely, compensating for the coats that seemed to stop at their heads.

He marched on, face now frozen. He would show them all strength. What he said mattered less: their speaking skills were probably as bad as Tutresh.

Oswald walked on, feeling the gravity in his calves, the heavy atmosphere on his chest and head, and the chill all over. They trod a compacted dirt road past ploughed fields, corrals, and mounds that defied quick categorization. Nobody watched them; the few natives they spotted had run hard toward the low, sprawling town ahead.

"Don't drop those!" His hand twitched at Vehra's snap, crinkling the pages. "You're not getting off the script that easily."

Oswald averted his eyes until Vehra looked forward again. There was some gratification in having a low opinion of somebody confirmed, but mostly it was a pain. This was a job, and that fool should know he always did his job.

He could make out two natives approaching, hundreds of meters ahead. Their hominid forms were familiar from George's images. Large mouths and eyes dominated the faces. Double-bent knees gave them odd gaits. Each wore a singlet and skirt, nothing blatantly symbolic about the muted colors.

Li massaged her stomach. "I can't believe we're dealing with carnivores." The impression was incorrect—they were omnivores, likely descended from predators—but it was a common one among the crew.

"Don't be afraid," Reyes said. "Act naturally. There's no danger."

The Kihoa were close now. Vehra turned around. "We'll handle the contact. You two wait here."

Reyes's pride nearly kept her walking. Li obeyed immediately. Reyes saw her, hanging back, long sleeves covering her wrist ports, looking so submissive to his command. It gave her a nasty thought that she tried to forget.

Vehra and Oswald went several steps farther, then stopped on the captain's cue. "All right, Pitt, start," he said.

Oswald didn't get the chance. The lead Kihoa began speaking, his words and notes flowing into a smooth whole. Oswald concentrated, gratified at all he comprehended.

"Newcomers, I am Yaru Ihham, *Kiahimado*. We have known visitors from stars before, and greet you. If you can comport yourselves by the laws and customs of our kind, you will be welcome to walk our roads."

Oswald cleared his throat, stalling for time to frame his response. "*Kiahimado, meihho nehoa*—"

"Pitt! That's not the script! I know what it's supposed to sound like."

"Captain, they've covered some of the ground—"

Vehra jabbed his finger at the papers. Oswald held his tongue, as his heel ground the dirt. The Kihoa, the Overlord and his escort, had overcome their surprise, and were regarding him with something like pique.

Oswald struck a pose, held the top sheet before him, and began reading the translation of the captain's greeting speech, wincing at points. ". . . travelers from a distant star . . . take us to a leading citizen . . ." Only the part about being merchants in search of trade meant anything.

Yaru took a curious pace forward. "You speak *RRoduhim*."

Oswald tucked the papers under his arm. "I have studied the other visitors' records. I have learned much." He ticked his head over. "The others have not."

Vehra glowered. "What are you saying?"

"They took me off-script, asking about you. I gave you a character reference."

"Oh." He preened himself for their appraising looks.

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Yaru fought to keep his back hair from rising in mirth. "What trade do you propose?"

"He asked about trade," Oswald told Vehra. He flipped to the appropriate page, and began explaining. He diverged after a sentence, figuring the captain hadn't memorized the sounds that far along.

"There is a certain precious metal, the name I know not in your language. We have a method to separate the metal into distinct varieties. We will keep one residue, which we need for our craft, and leave you the others, refined."

Yaru tipped his head. "This is all?"

"*Di*," Oswald confirmed, holding the note just above high C and feeling rather proud of it.

The Overlord took a while to answer. He spoke several sentences, then crossed his arms at the wrists and turned toward his town, escort in tow.

Oswald tried unsuccessfully to evade the heavy hand that fell on his shoulder. "Out with it."

"Captain, he finds our request dubious. He is returning home to consider it. If we come to town in . . . works out around four and a half hours, he'll tell us whether he wants to do business."

"You explained to him how important this is."

"I think," Oswald said sardonically, "he can figure that much out himself."

"You're here to translate, Pitt. I'm here to think."

Reyes stepped in at that propitious moment. "So we go back to the *Cortelyou* until then?"

Vehra spoke over a rigid jaw. "We seem to have no choice. Perhaps we should be grateful the door is still open at all."

He started slogging back to the hills. Reyes fell in alongside Oswald. "Don't let Captain Vehra see you clenching your hands in quite that throttling pose."

"Oh, will he execute me for mutiny? There go his negotiations."

"You don't need your hands intact to translate."

Oswald didn't even flinch.

Ahead of them, Vehra was peering back, and speaking softly to Li. "There's something we have to do for this next session. . . ."

The same group set out hours later, retracing the morning's path. Oswald punctuated their progress with frequent coughing, snorting, and spitting fits. He pleaded a sore throat, but his afflictions always seemed to mount whenever Vehra and Li drifted closer together.

Yaru's escort met them along the road, and walked with them into town. They passed buildings of stone and houses of brick, with wooden pens clinging to nearly every structure and teeming with animals. There were more mounds, here tightly enclosed, some plainly inhabited by small creatures.

Some of the people dared show themselves this time, mostly through windows, a stalwart few on the streets. They had to pass through a thin group surrounding a dwelling, notable for having two stories. The escort entered and held the door.

Inside was pebbly tile for floors, and smooth plaster walls with small tapestries hung all over. Reyes studied one: a series of colored diagonal lines, widths and spaces varying by apparent design, hues ranging from pale orange into oddly misplaced black. Ultraviolet colors, she surmised. Kuess did have a whiter sun than Earth.

Oswald barely noticed the artworks, but a motion down one branching hallway turned his head. She was female, her skirt longer and brighter than the men's. She shrank from his look, but couldn't master her curiosity well enough to hide. The sight kept him distracted all the way into the meeting chamber.

Yaru stood in front of a long bench, canted forward to match Kihoa physiology. Chairs lined the walls, considerably

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less practical for the visitors. The humans took their intended places, but Oswald couldn't let the mystery lie.

"Overlord, who was the female I saw here?"

Yaru tightened. "You must mean my daughter."

Oswald subsided, assuming he had offended Yaru. Vehra glowered.

Again, Yaru beat Vehra to the first word. "I have informed my communities of your arrival. The people are restless. They have unhappy memories of the Tutresh visits." Oswald rendered that into English.

"Tell them we aren't Tutresh," Reyes said.

"Tell them the Tutresh left long ago," Vehra said sternly. "Who really remembers?"

Oswald delivered both replies, in order, and sat through Yaru's rebuttal. "The impressions on us were deep; they don't—I think that's 'vanish'. Think fast. They're turning us down."

"Don't jump to conclusions. He may be angling for a better deal."

Yaru spoke again. "The one trade you promise, for metals you cannot name, is—is—'not worth' the possible harm; I'm guessing from context. You may remain among us a while, but for—commerce, go elsewhere."

Vehra was flushing from the rebuff. "Go where elsewhere? Can he suggest other partners, if he's so obdurate?"

Yaru considered the slightly modified question. "There are other communities, under other lordships. They will be—less tolerant of outsiders."

"Then what better offer can we make to change your mind?"

Yaru stammered over the first notes, but got out his answer. "I don't desire to negotiate further. It would be—a trunk—some kind of metaphor. Useless, he must mean."

Someone opened the door behind them. "No," Vehra said, holding his hands out to Yaru. "Wait one minute, please." Oswald had barely translated this before the captain was looming over him.

"You will explain to that alien that he is misunderstanding our offer, that your poor translating is distorting communication between us. You will beg his forbearance, and ask to start over, this time using the schoolboy vocabulary that is apparently your limit. Stay out of this, Miss Reyes." He stared down at Oswald. "Am I clear?"

Oswald stood himself, overtopping Vehra, but still looking vaguely ill from the browbeating. "No way I could misunderstand that, Captain. Give me a moment. This will be difficult."

Vehra stepped aside, while Yaru waited patiently. He was speaking wrongly, he had begun to realize. He hadn't thought so thoroughly inflected a language could still have syntax, but it should have been so obvious. Still, they had understood him—and would again.

He slipped naturally into a meek posture as he spoke, explaining that without the refined metal they sought, their ship was marooned on this world. It might seriously discomfort the Kihoa, but it would be unadulterated torture for him personally. They could see that themselves, with his superior's bullying, and his repulsive personal habits—which he hoped carried some sexual connotations.

Yaru's reaction took time to surface. "Marooned, you say. With—?"

"Yes, with—" A tiny finger movement finished the thought. "Please don't let him know I said this," he added with utter sincerity.

Reyes shuffled aboard the *Cortelyou*, exhausted. It was three hundred ship's time, but barely past dusk on this slow-spinning planet. She had held out to her limit during the tedious negotiations, still ongoing with the others. All she cared about now was sleep.

She dropped off in her uniform, seconds after touching down on her mat-

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tress. Her eyes cracked open six hours later, and felt as gummy as her brain. She got the time from George, then croaked, "Are the others back yet?"

"No, Miss Reyes."

She mumbled something, and felt her way into the bathroom. "What duties do I have?" No reply. Opening the door, she said, "You can follow me in. What duties do I have?"

"I'm handling the standing-down workload. Your time is free."

Reyes got the shower going, and began to revive. Soon music began running in her head: one of the Mozart updates she had mentioned to the captain. "George, do you have any Mozart on file? I mean the original, unadapted?"

"Sorry, no original Mozart is in my files."

"Okay. Just curious. Oswald must listen to the updated variety."

"I cannot speak to that. None of Mister Pitt's audio recordings are in my files."

Reyes stopped scrubbing. "That can't be. I saw his listings. He has recordings."

"They are on a separate computer, one he refuses to link with mine."

That did sound like Oswald. "You must have overheard some, though, when he plays it."

"He uses earpieces, and strictly guards his music in other ways. He considers even my passive presence an intrusion."

"Yes, we know that." She began washing again, to fill time. "There's no way you can link with his personal processor?"

"By physical connection only, and he would not agree if I asked."

She said nothing until she was dry and dressing. "He doesn't have to agree. We can do it ourselves. You can let me into his quarters—"

"I needn't remind you, his standing orders are unambiguous."

"But there's command override. If I must, I can enter."

"Where safety of ship or crew are explicitly endangered. What danger do you posit?"

"I—" She stalled until she was out of the bathroom and into the corridors. "I have a hunch, George. Our getting off this planet depends on his cooperation, and some key to his twisted personality is in the hands of composers who died three, four, six hundred years ago. I need to know." She came up short at his door. "*We* need to know."

"Miss Reyes, that reasoning is insufficient. You should move away from the door."

"George, you can't be threatening me. I haven't even tried—"

"Hey! I don't let you people in!" Oswald was in the corridor, looking no more tired than she still felt. "George, if she got inside without my permission, I'll—"

"She gained no admittance."

"Good. Get out of the way. I've got work; I've got sleep; I haven't got time!" He pushed by her to his doorway.

"Mister Pitt." She followed, stopping the closing door with her hand. Oswald pivoted, intent on violence. "I only—" The scene froze, until she simply said it. "I was interested in your music collection. Might I borrow some of it?"

"No!" he shouted. "I mean, yes. I mean—" He scrutinized her face, not believing whatever he found there. "You didn't come here for that."

"Ask George." Any details beyond bare bones would be ruinous, but she could hope.

Oswald looked up suspiciously, but not even he doubted the computer's veracity. "No, I don't loan out my things—but yes, I'll make a read-only copy. Wait here." He went to his computer, and slipped in a memory bar. "Keep this between us—you too, George—or no deal."

Both assented. "Thank you," Reyes added.

"You're—welcome." Hesitantly, he handed over the bar. "Don't say I didn't warn you." He shut the door fast.

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Reyes carried her prize back to her quarters, less concerned with his behavior than with not hexing her good fortune. She slipped it into a computer slot, wondering what to expect. Primitive sound production, artificially restricted tones and rhythms, no unity: that's how people dismissed it. Maybe those imperfections matched Oswald.

"Play a piece, George. Make it short to start."

The strange clamor struck her hard, all staccato blares, chimes, and whines. There was a crude, jerky order, but not what she'd call unity. "What is this?" she said to herself.

George gave her rhetorical question an answer, a wildly ironic one. "Is that so?" Reyes said more quietly. "If this ever 'got rhythm', it let it go right away."

But she kept listening.

Oswald walked down the familiar dirt road, sunrise at his back. The rest of the crew had their diurnal rhythms thrown way off, but six hours' sleep had revived him. Fine for his purposes.

How stupid he had been. The language wasn't just syllables and notes, natural inflection letting one glom them together in any order. The Kihoa made melody of them, not for utility, but for euphony. He must have sounded worse than slangy, worse than ignorant. Leave it to the Tutresh, with their two left brains, to miss that completely.

He'd made some adjustments during the later talks, as they gyred around trying to identify metals through his limited vocabulary. It took hard thinking, planning in advance, things apparently intuitive to the Kihoa. It was frustrating.

It was also enjoyable. When he did get a sentence to flow, it was like composing a good song by instinct. It was intellect and aesthetics in one. If only he knew *how* it came together when it did.

He walked on, wide verdigris plains and clear skies ahead of him. The cadence of his feet evoked a familiar composition, one he couldn't long resist. He whistled, stopped, then shifted the music between the lines into Kihoa notes.

He played the entire orchestra from his mouth, shifting from whistles to hums to wordless singing, even to the blat of taxi horns. He immersed himself in the piece, ironic title and all. An American, yes, but *far* from Paris—in space and time.

His élan waned with the middle blues, though his feet barely slowed. The delicate work of reproducing the music kept him from outright melancholy, but he perked up with relief when the mood rose again. He strutted as the music soared, fluttering his hands to the trumpet flourishes, then projecting the final crash of brass as far as he could. The intense coda left him breathless, dizzy, euphoric.

A chorus of soft, murmuring burrs arose behind him. Oswald snapped around. A small crowd, mostly juvenile, had gathered as he walked in his own universe. Their susurrations were Kihoa laughter.

He stumbled, nearly falling, and ran the rest of the way to town.

An unfamiliar face, wearing a familiar singlet, showed him into the Overlord's home. He found Yaru and his daughter in a den. Yaru looked with concern at the winded visitor. "Is there trouble? Where are the others?"

"I came alone, Overlord. I wanted your help."

Yaru tensed. "Are they abusing you again?"

Oswald stifled a brief temptation. "No. The help I want is with your language. I have learned as many words as our records contain, and my—" 'sequence' was the closest synonym he had "—sequence is now improving, if you understand."

"I do; it is." His daughter brushed his arm silently, motioning that she was leaving.

"Thank you, but I want to study fur-

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ther. If I had an instructor, or books, or—" Yaru drew back. There was a soft gasp in the hallway behind Oswald, and hurried steps. "Is something wrong? I understand books are scarce . . . have I been offensive?"

"Have you?" Yaru stalked slowly forward. "What do you know of my daughter?"

"Daughter!?" Oswald retreated, quickly catching the wall in his back. Bewildered, he fixed on Yaru's hands, their pads tumescing into coarse tearing surfaces.

Yaru halted a pace away, and looked down at his hardened, outstretched hands. "You couldn't know." He willed them to soften, and Oswald resumed breathing. "I would not have reacted this way, were your words not so—" The word was unfamiliar; might be 'personal'.

"I don't understand how."

Deliberately, Yaru backed away, beckoning Oswald away from the door. "It is—disgraceful for one's ear to be *intu*."

Oswald recognized the low-toned word from yesterday: lead. The connotation was clear. "Does she not hear," he asked gingerly, "or only like my shipmates?"

"Like them," he whispered. "She cannot comprehend by listening, not easily, not without patience. She . . . needs books. You do not, so I presumed you were mocking, and I do not tolerate that."

Oswald wanted to correct his impression, to say so many things, but only one meant much. He groped for the proper Kihoa metaphor. "I hear your heartbeat," he finally said, ". . . and hers."

Yaru understood. He picked up his head, ears straining. "Let this unhappy subject go. I think our wares are here."

Workers carried numerous metals inside, mostly in fashioned goods. The *Cortelyou*'s engineers would try to pick out anything with osmium. They all went into the meeting chamber, giving it a marketplace's appearance.

"I better not touch these. My shipmates have the expertise. They'll arrive in a while."

A renewed uproar outside upset that timetable. Yaru and Oswald found them at the front door, all save Kayah Mon. Thus, she was the only one not looking incensed.

Captain Vehra spoke in hard, low tones. "I got a chance this morning to listen to what you said yesterday. We all have." He waited for a reaction, and got none. "I thought you would take this seriously, Pitt. Instead, you've committed blatant insubordination, lied outright, sabotaged my negotiations—"

"Which were going so well when I began my sabotage." Oswald controlled his voice, for the Kihoa's sake. "Fine, I made up some stories, and they worked. No points for that?"

"You slandered me! Made vicious accusations!"

"Yeah, yeah. Thing is, how'd you figure it out? No mystery that George did the translating, but who recorded. . . ?"

His hand clutched Li by her long sleeve, bringing a sting from the hard surface he encountered at her wrist. "Tell me," he said, "how long did he beg before you let him plug it in?"

Li matched his vitriolic glower. "He didn't have to beg at all." Oswald was too flabbergasted to dodge her slap. Li got her hand free, only to have two Kihoa pin her arms.

Vehra smartly stepped inside to avoid a similar fate, but found Yaru looking intently at him, and looking much more like a natural predator. Oswald grinned to the incisors. "Hello, massa. Bottom rail on top this time."

The captain could only yammer, so Reyes took over. "What are you planning?"

"Why, to keep doing this job, ma'am, the best I can. If that means correcting your mistakes, fine. If you object, there are always alternatives."

He watched Reyes cock her head. "Oh, not for you; you're stuck with me. My alternatives are to tell the Kihoa what

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to look for on Li's and Zheng's wrists, or break down and admit what the captain does with me in his quarters—"

"Or to strand us here if we don't knuckle under to you?"

Oswald snorted. "I thought you were smarter than that. I'm getting us off this planet. I'm doing what none of you can. That's enough for me. Should be enough for you."

He briefly explained the "misunderstanding" to Yaru, and that confrontation dissolved. Yaru summoned them toward the meeting chamber. Vehra wouldn't look at Oswald as he passed. Zheng and Li did, with undisguised loathing. Popescu ignored Oswald, instead staring in disbelief at Li.

Reyes brought up the rear with Oswald, not disregarding like Vehra, just shaking her head. Oswald wouldn't react, but did fall a little behind as she went in.

He didn't follow. A quick motion registered in the side of his eye. He looked, saw nothing, then heard a breath around a corner. Four steps, and he was with Yaru's daughter. She had leather-bound tomes in her hands, pressed to her chest.

Her voice wavered between notes, hitched, and found a pitch. It was the wrong one, and Oswald had to gesture for a repetition before he understood. "Do you really want books? To study?"

"Yes. I need to know the language better. Books could help."

She hesitated, then bundled the books into his arms. "I hope they help," she said, Oswald figuring the proper tone himself this time. She turned.

"Wait." Oswald fumbled while she waited. "Wh-what is your name?"

She bowed her head. "Imsah."

"Pitt!" bellowed Vehra from the chamber. "Where have you gone?"

Oswald held his place. "Thank you, Yaru Imsah." He backed away awkwardly, holding the books in the same pose she had.

* * *

Nobody grilled Oswald about the books, through scorn or disinterest. Yaru did note them, but held his silence while the humans worked.

Li examined the metal objects. Sight and touch seemed hopelessly inadequate, but she had a trick up her other sleeve: a passive spectrometer. She kept the scanner head hidden, while the readings went directly to her brain.

She huddled with the others after a long session. "Some of these objects are made of platina, with significant osmium content, but there are no refined metals. We can use the *aqua regia* method to commence osmium extraction, but apparently the Kihoa don't have this method, so we'll have to conceal our procedures."

"This society is late-medieval equivalent," Vehra objected. "Couldn't *they* refine platina?"

"We can ask George, sir," said Zheng, "but the question's irrelevant. The Kihoa haven't isolated platinum, or osmium, so we must."

"You can't use these pieces," Oswald said. "The owners want them back intact."

"We know," Li said, spearing Oswald with a glare. "We will need access to raw ores, and we'll have to separate them aboard the *Cortelyou*, or risk exposing our technology."

"That could raise suspicions," Vehra said. "Well, can't be helped. Yaru, can you—"

"Captain, we agreed."

"Oh, yes. Noemi, ask him where he mines his—Li, show him the closest thing."

Reyes delivered the message, removing the taint of Vehra's imputed personality from the equation. Oswald translated, stumbling over the concept of mining.

"That variety comes from a river bed near *Unhhage*. It's under my overlordship, about eight thousand paces away."

Vehra blanched at the prospect of an

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extra ten-kilometer trek each day. "Say we need to find the metal ourselves. Explain the difficulties, and reiterate the bargain."

Yaru's reply was long in coming. "I will arrange it, but make your work short. May I return these to their owners?"

The answer was affirmative, and the latest session began breaking up. "Seems they like us enough to impose a deadline," Michael said to Oswald. "Good work."

Oswald began making soft, croupy, rhythmic sounds. Michael colored, wheeled and bumped into Li, and almost came apart. Oswald masked his amusement, instead getting next to Reyes.

"I've got some books here—I'm trying to learn more of the language—but it figures I need someone to teach me the notations." He flipped some pages, showing the lines and dots he meant. "I think I can get help here, but it means staying behind."

"You're asking permission? I don't object, but the captain—"

"What about me?" Reyes got him up to speed. "Oh, that's what they're for. All right, but I'll need him once the mining party's outfitted."

Oswald nodded, let his crewmates pull ahead, then went to ask Yaru a large favor.

They came to collect a diffident Yaru and a recalcitrant Oswald three hours later. They made good time to *Unbhage*, the Kihoa's leisurely pace fatiguing the humans. Workers at the diggings resisted their involuntary vacation, but an Overlord was an Overlord.

"They will want to see plentiful results from whatever you do," Yaru told the group.

"If you say so, Pitt," Popescu said. Reyes quietly reproved him.

The head of the diggers still had objections, and demanded he speak to their *ahimado*. "Exactly what I intended. Come with us, if you desire." His out removed, the chief sent his men home, and prepared for the audience.

Zheng and Mon had to perform their analyses, preferably in seclusion, and they retained Michael to relay any lucky strikes back to the *Cortelyou*. Reyes and Pitt went with Yaru on the relatively short jaunt to *Unbhage*.

Oswald looked back, and judged them out of earshot of the diggings. "So, sick of my music yet?"

Reyes went off-stride. "Should I be?"

"It's what I'd expect. Have you even listened?"

"Yes. It's . . . strange. It shouldn't make sense, but sometimes it does, in a way."

"That's what I think of modern music, except it doesn't."

"And what's so wrong with it?"

"It's too perfect. No, wrong word. It's too precise. Synthophonics can manufacture any pitch, any timbre, any conceivable sound. Compositional creativity is impossible; the hardware's used it all up."

"Does it matter where the creativity originates?"

"Yes. Musicians don't need to stretch, so they don't try. Music can sound like anything, so it doesn't mind sounding like nothing. It's so . . . puerilely self-satisfied." He stared at the pale sky. "Alien contact spoiled human music."

Reyes frowned. "I won't listen to a xenophobic diatribe."

"No, can't let anything get in the way of Change." He boomed the last word. "All the alien races tell us we're so flexible. They plop all their embassies and cultural exchanges on Earth, because we have the adaptability to handle them. Maybe so, but we've gone crazy showing it off, pleasing them, forgetting that change doesn't axiomatically equal progress."

"That's an old argument, making simplistic points."

"Like the point that you don't take musical advice from a tin-eared species." He covered his mouth and gasped in phony fright. "Please don't let the captain hear I ran down the Tutresh."

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Reyes didn't take the bait. "Contact with different cultures has given all of them new variety. I'm sorry you don't comprehend that."

"Right, new variety—at the expense of old varieties. Humans have worked hard burying or transmogrifying old culture to exalt the new, modern one. Where's the variety in that? Where's the strength in art forms that can't stand some competition?"

She ruminated on that. "You just don't care for modernity?"

"I like modernity enough. It's today's version that chafes me."

"You prefer Gershwin's version? Mozart's?"

"That's right." He caught her looking askance. "You think that's absurd. It isn't. Read about where Gershwin lived and worked, New York City in the 1920s and '30s. It was lots like Earth today: ethnic mixing, cultural ferment, old and new contending for primacy. Difference is, they got it right back then."

"I'll have to ask George about that. The *Cortelyou*, I mean."

"He won't know. I'll have to go get it for you. I don't have time for this."

Reyes looked back at the now-distant river. "I think we might."

Lord and Overlord stood in the tiled atrium of the former's home. Their voices were raised, but not to shouting. To Reyes's ear, the tension they suppressed was worse than what they loosed on each other.

"You let them into your town," Oswald softly translated from Lord Ua Ragho. He didn't want them recalling their presence right that moment. "I disapprove, but that is your prerogative."

"And here as well. I am Overlord."

"I have rights over *Unbbage*."

"You do, subject to higher authority. Relations between races from different planets demands—um, execution of that authority."

The mining chief advanced from his place along the wall. "Lord, if he can do this, you may as well be—"

"I have heard your petition!" Ua barked. The chief retreated. "Overlord, this is immensely important—too important to leave to arbitrary decision. Uh-oh."

The last words were Oswald's alone, and accurate. Yaru stretched his already erect carriage. "Is this a challenge?"

Reyes began stepping forward, but a jerk from Oswald balked her. "I wouldn't do that."

"I can defuse this, help them reach a compromise." She wrenched her shoulder without success. "Translate this, Mister Pitt. That's a direct order."

Before she could speak, Ua said something brief. "What was that?" Reyes demanded.

"He said, 'Not yet.' Now, you wanted me to translate something?"

He ended up translating Yaru's assurances of compensation for the idling of the diggings, and a stiff reply from Ua that was an acceptance in name alone. "It might be best for all," Yaru added, "if your townspeople minimized contact with the humans."

"Gladly granted, Overlord. A swift trip home." He made a perfunctory obeisance and departed with marginal civility. The chief left with none.

Yaru approached the humans. "I trust you can work efficiently, and promptly."

Reyes nodded solemnly. "We always intended to be done as soon as possible."

"Good. I will assign you a small number of guardsmen. You need not supervise them. They will know their orders. Come, we shall inform your companions."

They fell into line, Oswald close on Reyes's heels. "I didn't change a note, ma'am. Whatever my word's worth to you—"

"I believe you, Mister Pitt." She didn't think to add "This time."

They returned to the ship at around

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sunset. Oswald disappeared into his room for a moment, then came out without the expected memory bar.

"You can access my musical files through George now. Everything else is still locked. Excuse me."

Reyes stopped him before he got to the hatch. "Where are you going?"

"Back to town. My language tutor won't stay awake all night."

"Mister Pitt, I don't think Captain Vehra will gladly have you out unsupervised again. He was mad enough you stayed behind this morning."

"Then don't tell him." He tried and failed to get by. "Are you so opposed to my improving my language skills here?"

"No, but you can do it tomorrow, with supervision."

"Yaru and I had an agreement. We—forget it." He trudged back to his quarters, disappearing without another negative sound.

Reyes didn't long savor her cheap victory. "George, I need to speak with Miss Li."

"She is unavailable at present."

"Really." She started for the engineering compartment. "Is she aboard?"

"Yes. Shall I summon her?"

"Thank you, yes."

Engineering had all sorts of equipment scattered on the deck, a miniature ore refinery in the making. Reyes began inspecting some items, and soon forgot any other reason for being there. Proper alignment; batteries charged full; could use a quick cleaning . . .

"I've checked them out, Noemi."

Li's voice shifted Reyes back into reality. "Double-checking never hurts. Can you take any of this on-site?"

"Too bulky. It would be obvious to any Kihoa who happened along. Better we bring the ores here. What?"

Reyes had fixed on a flap of material over Li's shoulder, from a half-fastened sealer. "Just thinking," she improvised. "We can borrow wagons, but the Kihoa don't use animals for . . ."

Li had found the loose flap, and was staring back as she sealed it. "Surprised?"

"I . . . think we had figured it out. Qing, if you want to talk—"

"Nothing to talk about, unless you're asking for intimate details." That shock gave her breathing space. "Did you expect I'd end up with Pitt?"

"No! But . . . Captain Vehra—"

"—doesn't torment me, invent innuendoes, tear me or anybody else down for sport. He makes an effort to help me fit in, like you do. You don't question my appreciation for you, so don't talk about me and him." Her eyes narrowed. "And if I frustrate Pitt's little sabotages in the bargain, he is welcome to choke on it. Is there anything else?"

Reyes did segue awkwardly into a discussion of their refinement prospects. It rattled her that she had come close to a defense of Oswald. Strange what some borderline normal behavior could do to one's perceptions.

". . . *unghi* . . . 'mind reaching' . . . imagination?"

Imsah beckoned Oswald on. He explained 'imagination', creating unknown or impossible things in one's thoughts. "Yes," she replied. "That is *unghi*."

"Good. It is confusing, though. I would expect 'imagination' and 'creativity'—*unghi* and *hhurran*—to have common roots, common sounds."

"Your words for them have no common sounds. Do I hear them right?"

"Yes. Yeah," he said, dropping into English and grinning sheepishly. "So much for my theories."

He was in his third day of lessons with Imsah, not counting the occasional summons to interpret some trifle at the diggings. He had slept in a small guest room the last two nights, the first one after hiding in his quarters for three minutes to slip Reyes's leash.

There was a rapport. He had a knack for intuiting the proper tonality of her speech and compensating instantly. She

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had quickly deduced what holes he had in her language, and filled them vigorously. Many definitions followed from agglutinations of smaller concepts, but when a word needed interpretation, she always managed to find the right connection. He considered it the one genuine piece of good luck he had had in years.

"Are you hungry yet?"

Not particularly, but he needed a reprieve. "Yes, a little."

She left to get his lunch. Their food was perfectly edible for humans, something he had learned by realizing after his second meal that he wasn't violently ill. She seemed to be slanting their natural diet away from meat for his sake. It didn't much matter to him. Food was food.

He walked around the room, stretching his back, and stopping by the same old tapestry. He craned his head to see the lines slanting nearly to the ceiling, then bent close to examine the stairstep, almost mathematical progression of the stitching.

The door swung behind him. "This tapestry is growing on me."

Imsah dissolved into whispering burrs. Oswald quickly corrected himself, discarding the metaphor that didn't translate into her tongue. "Where did you get it," he asked, "or is it your father's?"

"No, it is mine."

"It's good. Abstract, but I like it. You didn't say who—" He suddenly deciphered her silence. "You, Imsah?"

She wouldn't deny it, and that was enough. "They are . . . what true sound looks like." She was looking past him. "When I imagine," she added, inflecting the first syllable of *unghi* a semitone higher.

Oswald took a long look. "Of course." There they were—the tones, the melodic line, the rhythms of speech. It made sense.

She slipped away during his reverie. She always left him alone for meals. Kihoa liked their privacy—and so did Oswald. He ate with half his mind, trying to interpret her woven words with the other half.

A distant murmur slipped into his meditations, soon growing too loud to ignore. Something was brewing outside. There was a hasty slap at the door. Oswald opened it for a badly agitated Imsah.

"Pitt?"

"Pitt!"

Those were human voices. They hurried downstairs, to find four of them gaining entry. Popescu and the engineers all carried heavy sacks and bags, and were dripping with sweat.

"Ua's coming," Li panted, "and half his town's behind him."

"A mob swept us off the river," Mon added. "Never attacked—on our heels all the way here."

"They toyed with us," said Zheng. "I don't know the language, but I know tone of voice. They mocked us at every step."

"That's right." Michael swung a loaded pack off his back. "Where were you when we could have used a little communication, Pitt? How much did your lessons help us?"

Oswald couldn't reply before he saw Ua step across the threshold. The Lord ignored the humans contemptuously. Oswald saw Yaru in the corner of his eye, the target of Ua's scorn.

Ua bunched up his skirt at both sides, squatted, and began defecating right in the vestibule. The digging team recoiled toward Oswald, who stood with his jaw swinging. Ua took some time finishing, then stood and walked outside. A very grim Yaru followed.

Oswald began convulsing. The other humans and *Imsah*, got him into the nearby den and laid him down. As they began debating what first aid to apply, he shrieked. It was an awful, shrill, spastic noise. It was laughter.

"Ri—right on the floor!" he gasped. "Beautiful! Must have been saving it the last two—" He surrendered to intermittent howls again.

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"Pitt, get hold of yourself." Zheng knelt and slapped him across the face. Oswald drew back a fist, but the sight of Imsah stayed his reprisal. "Imsah, what did that mean?" His composure was back, except for regressing into bad syntax.

Her visage hovered close to fright. "He challenged my father's overlordship," she had to state twice for Oswald. "Once they choose rina, the combat ritual will begin."

Oswald didn't get rina—plural people of some sort—but the rest was plain enough. He explained it to his crewmates. "How do we stop it?" said Mon.

"I don't think we do," Zheng said. "Hey, where are you going?"

Oswald had scrambled up to ask Imsah the same question. "To watch," she said.

"Out there, with the mob? No way. Upstairs."

She accepted his direction readily enough. The others followed without being asked. "Butt out," he snapped at them as they piled into Imsah's room.

"This concerns us too," Michael said. "We're liable to get run off Kuess, or worse, if our man loses."

"Maybe you should get your things back to the ship, just in case."

"Maybe *you* should do some honest work yourself!" He hurled his pack to the floor.

"Quiet!" Only Oswald knew the word, but nobody missed Imsah's meaning. She leaned through the short slit in the wall, her breath hard and tense.

The enemies stood in a small plaza next to Yaru's house, their shoes discarded. Spectators choked all the nearby streets. A trio of onlookers stood just within the clear space around the lords. One of them gave a signal.

Ua came at Yaru, arms wheeling. Yaru dodged him gracefully, and sent a leg arcing over his head. Ua responded with low, sweeping kicks, which Yaru bounded over with difficulty. He slashed at Ua's face, missing by a centimeter.

"What is this?" Oswald muttered, elbowing Zheng as he tried to peer through. "He could have connected with that." He leaned close to Imsah. "Explain their intentions."

Yaru's hands jabbed past Ua's head like pistons. Ua avoided the blows, but could not counter until Yaru relented. He reared back and sprung, tucking and tumbling to his feet perfectly as Yaru hastily gave ground.

"It's gymnastics," Michael sneered.

"No," said Oswald. "It's what Imsah called it. Combat ritual, accent on ritual. It's a display of skills, offensive and defensive. They're not supposed to strike."

He consulted again with Imsah, as the two circled each other. Ua looked at them, and Oswald impulsively made a face. Ua snarled, and made a clumsy lunge at Yaru.

Oswald cackled softly. He pulled faces and made insulting gestures every time Ua's eyes might be on him. His scheme gained progressively, as Ua's feints lost grace, even the intent of grace.

One creative use of the tongue finally unhinged him. Ua delivered a stunning blow to the chest, and a rip sounded across the plaza as Yaru fell. Ua tried to follow up, but the *rina* were there in a trice to restrain him.

Imsah gasped, and pushed past the engineers to go to her father. Oswald stayed at the window, watching the dénouement.

Ua struggled against four restraining arms. "He gave himself up!" he roared. "He made no attempt to dodge. I claim a forfeit!" Two voices softly denied him. He appealed anew to the rina bending over Yaru, and received stony silence. He pulled himself free, opening his arms to his townsfolk, but they were melting away.

Imsah ran into the plaza, but her father was already standing. His singlet gaped from a slash, the flesh beneath untouched. Yaru caressed her briefly, then detached himself. He stood, watch-

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ing Ua, waiting. The defeated, wilting lord trudged toward Yaru's door.

Oswald went downstairs, wondering what could come next. He found Ua kneeling in the vestibule over his own filth, scooping it into his skirt, wiping the tile clean with a loose fold. He slunk away, leaving the house before Yaru and Imsah would deign to re-enter it themselves.

He almost went to Imsah, but something told him this was a moment for family. He headed out of the house, trusting his shipmates to do the same eventually.

A few hundred meters from the house, he spotted Reyes approaching, disoriented. "Pitt, what's going on? I was walking here, I saw a huge crowd arrive, and now it's leaving. What happened?"

Oswald opened his mouth, and sputtered. He fought, but laughter overwhelmed him again. He thumbed over his shoulder, at the house where his crewmates still were. He walked past Reyes, not noting her astonishment, still doubled and gasping.

Reyes passed two of Yaru's guards patrolling the periphery of the diggings. Unhhage was no longer a threat—they had no new lord, much less a new challenger—but Yaru preferred to maintain the symbolism. They regarded her politely as she passed. She hoped those unruffled gestures were a sign that the worst was behind them.

Mon was running her passive spectrometer over a load of ore. "Where can I find Pitt?" Reyes asked her.

"In the tunnel, and could you please ask him to stop his so-called singing? If I hear any more yowling about taking long pulls or Allen's Town, we may launch shorthanded."

"I'll talk to him."

Ore recovery had increased markedly in the last three calm days, and processing was well underway aboard the *Cortelyou*. The digging team needed new help while Li worked on the ship, and had nominated Oswald by popular acclaim.

She found him emerging from the tunnel mouth, silently hauling a cart of ore. His occasional redolence was back in strength. "Hello there, ma'am. Care to catalogue my latest injuries?"

"I would, if you were being serious."

"How serious do I have to be?" He spread his arms, displaying his soiled uniform. "Limping serious? Comatose serious?"

"You're part of the crew. You can work like everybody else."

"Oh, like you."

Reyes lifted her eyebrows. "Yes, like me. So, I hear you have complaints."

"Hearing and listening, different things." He resumed pulling the ore. "Can't even get back to town. Supposed to sleep on-site, not waste my strength with frivolous trips. It's a waste of my talent."

"Your command of the language is strong enough. No big misunderstandings."

"I can do better. I should. You'd think the captain would be interested in a more comprehensive lexicon, anyway. Make a present of it to the Tutresh. Easier than finding the proper orifice on them to kiss."

"Pitt, you said the others object to fruitless trips forward and back."

"That's right."

"So do I." She left without another word. Eventually, she heard some kind of song droning from him, and didn't care how the others reacted.

An hour from the ship, as darkness descended, she began having second thoughts.

"That's a very good point, Noemi." Captain Vehra was in pajamas, a victim of resurgent circadian rhythms, and had almost retired when Reyes reported in. He sat on his bed, turning a small module over and over in his left hand.

Reyes watched the box tumble between his fingers. He had programmed

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that translator module two days ago, saying any of the engineers could wear it, and remove Oswald's pernicious presence from the communication loop. The Kihoa didn't trouble him, and neither did Oswald's intimidation. Despite telling himself these things frequently, he hadn't used it yet.

"It's a golden opportunity," he went on, "an addition to their scholarship, sure to make them overlook any inadvertent transgressions of the Interdict. Superb idea of yours, Noemi. Go to the river, tell them Oswald is released for collection of cultural data."

"Yes, Captain." A premonitory ache pinched her feet. "Extraction's going well enough, they can probably work shorthanded."

The module stopped flipping. "Oh, maybe that's a bad idea." Reyes's ache spread.

"Are you serious?" Oswald shouted. "Oh, of course you're serious. You aren't cruel enough to play that kind of trick. Hooray!"

Distant Kihoa guards turned at his outburst. Reyes stayed more calm, wondering whether she had just been complimented, or wanted to be.

"Don't feel too bad," Oswald said to the other workers, eyeing him balefully. "It means this'll be the last song you hear from me. 'Oh, I—'"

"Pitt!" Reyes stopped his song cold at two notes. "First things first. What work are you leaving off?"

Pitt glanced toward a wagon near Zheng. "I had sorted ores to take back to the ship. Suppose he can do it himself now." He started skipping away, whistling to himself, until Reyes's actions caught his eye. "What are you doing?"

"My new job." She looped the attached rope around one shoulder, and started pulling.

Oswald turned red. "That rat. That fat, incontinent—" Reyes didn't see him until his grip on the rope jogged hers. "Going my way, ma'am?"

* * *

Their commiserating deprecations of Vehra didn't last long. They shifted into general complaints about a race that would eat animals, but not learn to hitch them up. What a world, where pack animals might break technology taboos.

The lament didn't last: neither carried a grudge against the Kihoa. It did burn off the general resentment, making their chore bearable— nearly pleasant. Oswald carried his part of the load tirelessly, despite doing without his crewmates' genetic adjustments for higher gravity. He began belting a few bars of the song he had begun before, but remembered himself and trailed off.

"*Porgy and Bess*, right?"

"That's right. You listened to it?"

"The whole thing." She smiled at Oswald's impressed whistle. "I knew you would ask eventually. Strange story, that."

"You say that about all my music. I say it about all yours."

"No, the music actually came together. I had trouble with the plot, but I guess Gershwin had nothing to do with that."

"He did too! All right, what were your problems?"

Reyes gave examples, and soon found herself immersed in something half lecture, half Socratic debate. His explanation of the plotting of operas was plausible, but seemed self-serving. He struggled more with her dislike of Bess's weak character, claiming dramatic necessity, then tying it to other characters.

"She doesn't see Sportin' Life as a villain, because he doesn't play strictly as a villain."

"That can't be, Oswald. You said he was a Satan character."

"Not the fire and brimstone version. That's the key. He's temptation and deception. His badness isn't doing wrong, but leading others into it. Bess takes his 'happy dust' of her own will, as far as drugs leave you one. His blasphemies aren't crude like Crown's. He makes it

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entertaining, humorous, draws in his audience rather than working against them. The music symbolizes that."

"You mean the title, "It Ain't Necessarily So," leaving room for ambiguity?"

"That's part of it, but I mean the music itself." He whistled some, concentrating on the rhythm. "It's sinuous, writhing—serpentine. *The* serpent. Understand?"

A smile dawned across Reyes's face. "I do. Imagine him chancing on that."

"It's not chance!" He spied a couple Kihoa ahead, startled by his vehemence. "Perfect sound production has ruined music," he intoned softly. "It's so literal, people today can't catch subtlety, undertones. If the connection isn't direct, anything else appears coincidental. That's real impoverishment, worse than anything on Catfish Row."

Reyes nodded, half to herself, half to the natives now passing on the road. "There's still something confusing. Sportin' Life, this villainous fellow, takes Bess away to New York. But you told me New York was Gershwin's milieu. Why would he portray his home and inspiration as a den of iniquity?"

Oswald laughed. "Because New York was like Sportin' Life: energetic, vibrant, seductive. Gershwin knew it too well to think otherwise. He could accept Ea—New York for all it was, the good . . . and the bad."

He fell silent, pulling his weight. His head drifted toward the road branching off toward town. Reyes noticed, as she assumed he intended. "Go ahead, Oswald. I can manage from here—and thank you."

"Yeah. Uh, thank you." He didn't fake reluctance well, and was soon jogging away. Reyes shifted the rope and carried on, getting accustomed to the new silence, and new perspective.

Noise filled Engineering, but the deck vibrations were more intense still. The engineers hovered over the Bose-Einstein condenser, ready to leap on any slip. Vehra and Reyes watched from a distance, respectful of their workspace.

". . . adjust top capture laser, zee plus point one . . . shunt to circulators, mark . . . atom beam density reads within limits."

Zheng and Mon turned, as far as their connections allowed. "Finished," he said. "That's the last of it."

"It all checks out?" Vehra said. "You're certain?"

"Osmium impurity was under one part per million," Mon answered, "and we filtered that out during condensation. All readings confirm, tachyon systems are back in full operation."

"Finally," he sighed. "When can we launch, Kayah?"

"If necessary, tonight, but we'd prefer to run diagnostic tests. Will tomorrow suffice?"

"Oh, I suppose so."

"We will have enough to keep us busy until then," Reyes noted, walking toward two large containers. "For one, we have these to deliver."

"Oh, yes." Vehra hesitantly approached them. "Introducing metals they hadn't known before. We're bending the Interdiction." After a lingering moment, he clapped his hands. "Still, a bargain is a bargain. The Tutresh will understand."

Reyes lifted one lid slightly, examining the flat, whitish sheets of pure platinum inside. "I should carry one of these. It's appropriate we have a high-level officer involved." She straightened her crouch. "Or would you prefer to complete the trade, Captain?"

Vehra tapped his fingers together. "I'll leave that to you, Noemi. Take whomever you need for the other. Michael's not busy. Oh, and bring Mister Pitt back with you. Time for him to stop compiling and start organizing."

Yaru picked up a cylindrical ingot of cloud-silver iridium, shifting his head to catch it in different lights. Popescu recited, through Oswald, the care they

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would need in working the slugs, for the fires Kihoa could produce would not melt these metals. Yaru took a second ingot, struck the two together, and then laid them aside. "And these other metals?" he said.

Reyes stepped forward. "They are all different, have their own properties." Yaru bent to examine the small piles of rhodium, palladium, and ruthenium with a hard, skeptical eye. "Are you satisfied with the trade?"

He straightened and said something to a nearby Kihoa. "We will test these metals, but yes, I am pleased. When do you depart?"

"We planned for tomorrow," Reyes said, "but we can leave earlier if you wish." Oswald shot her a glare, but translated accurately.

"No. I wish to hold a short ceremony, honoring our friendly relations. You were nearly driven from my lands, and I wish you to leave with better memories." He named a time, roughly ninety minutes after sunrise.

"I will discuss it with Captain Vehra. I think he will agree."

Popescu fidgeted. "Are we done yet, Miss Reyes?"

"I think so. We hope to see you tomorrow, Overlord."

He replied in kind, and Oswald followed up on the interpretation. "Ma'am, I was hoping we could stay on longer. A day more, maybe."

Reyes walked toward the door, forcing him to follow. "We have computers to deliver, Pitt, remember? The captain won't delay that any further for your studies."

"He wants that expanded lexicon, doesn't he?"

"You have expanded it, but that's a premium, not our main job."

"Please, you don't understand. I was finally learning the rules of their melodic syntax. I thought I had figured it out, but it's so much different. Imsah's worked with me all day on it, even ate lunch with me. One day could—"

"What did you say?" Reyes looked back for Popescu; he was trailing a couple dozen meters behind. "Pitt, what were you thinking?"

"Don't go crazy. I know their taboo about eating together. She initiated it, not me, so what's the harm?"

"The harm!? Didn't you study the cultural guide George compiled for us?"

"I skimmed it. I had other things to learn. Now what's so terrible?"

"You really—?" Her horrified expression froze, and abruptly vanished. "Never mind, Pitt. It's a closed topic."

"Not with me," he said, but his entreaties got no response. The familiar rhythm of walking dulled his anger into silent sulking, then into wondering what harm Reyes had so feared.

He banked his curiosity until he was safe behind his door. "George, display your Kihoa cultural guidelines about eating."

"It is rather late to be studying them."

"Just do it." Oswald dragged a chair over, straddled it, and read. He fixed on one paragraph, staring at it until his eyes hazed over.

". . . believe the habit is a carryover from primitive predatory instincts, eating alone to guard one's kill from scavengers. Anecdotal evidence supports this interpretation. Exceptions are made for the feeding of children, and for the socialization of couples, formalized or other. Cultural momentum appears unlikely to shift . . ."

Oswald fought to make his mouth work. "G-George, this part, 'socialization of couples'. That, that means friends, right? Just limited to two at a time."

"The passage refers to mated pairs. My apologies. I should have been more precise."

The word 'mated' winked in before 'couples.' Oswald cringed at the instant, clinical mockery. He lurched off his chair and into the corridor, imagining he was leaving George behind.

What could possess Imsah? What

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could lead her to such pointless emotions, so far as to forget they were alien to each other?

His stumbling momentum ebbed. What indeed? What else?

Michael had kept his distance from Li Qing for some days. Now, though, he sat next to her in the mess, finishing up a lively chat. He barely glanced at the opening door, and their talk sank into silence.

Oswald was paying them no heed, walking through his own corner of the Universe. He took cold rations and sat, murmuring some lilting tune to himself. "Morningtime and eveningtime . . . summertime and wintertime . . ."

A silent understanding passed between Popescu and Li. "Physiology's a strange thing," he said, voice above the merely conversational. "So many ways of performing the same functions. Take the cloaca, for example. You know what that is, right?"

"Certainly. It's restricted to lower animals, though. Birds, amphibians."

"On Earth, yes. Other worlds are much different. There's no biological law stopping it from appearing in any species, even sentients."

"I'm glad it didn't appear in us."

"Oh, I certainly wouldn't like it. The same orifice for urination, defecation, and reproduction. Everything out—or in—the same way. Talk about getting down and dirty. . . ."

There was a clatter behind them. "Michael—"

"I hear him." He blocked the swing of the tray with one arm, and delivered a glancing blow to the jaw with the other. By the time he stood, Oswald had recovered his balance, and was coming again. With a fierce grin, Michael went to work.

Oswald's breath was a reedy whistle, piped through tubes in his bloated nose. His inhalations sometimes hitched in pain, with receding frequency. Reyes checked the bandages and splint again, then scanned the readout of the pulse-resp monitor on his neck.

"Numbers look good. He isn't feeling the worst of it anymore." She wiped her forehead. "I think he's safe. Thanks for talking me through the rough spots, George."

"Pleased as always. I will monitor him for signs of any worsening. Take some rest."

Vehra caught her leaving Oswald's quarters. "Well, how is he? No, hold that door!"

It slid shut behind her. "The lock is disengaged. Crew safety. George confirms it." She lifted off a white smock, lightly smeared with blood. "Popescu broke his nose, two ribs, and the left wrist, along with delivering numerous cuts." She shuddered at the recalled image, Oswald's face a worse fright than ever. "Whatever scratches Popescu has, he can handle himself."

"That's no proper attitude. Pitt got his desserts. He started this fight; George verifies it."

"Yes, I've questioned George. His observations didn't start with the first blow. I heard what Popescu—and Li, but mostly him—were saying."

"You're telling me some innocuous words that touched one of his thousands of raw nerves justified his violence?"

"Captain, these were deliberate insults of the worst kind. George, replay that audio."

Vehra listened in bafflement. "What offense could he take from that nonsense?"

Reyes had hoped to avoid it, but she had reckoned without his fabulous obtuseness. She explained Imsah's actions, adding the cultural information to guarantee comprehension.

Bafflement shifted to astonishment. "The Overlord's daughter is in love with *him*?" A laugh burbled out. "So that means he—?"

"Presumably so. Popescu aimed his comments directly at that."

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"Is that so?" His eyebrows knitted. "Wait. The Kihoa don't have cloacas."

"If Oswald had studied the cultural files better, he might have known that."

Vehra spilled laughter again. "How devious of Michael. Oh, how—oh, my. No, this isn't good, not at all."

"You're right. We can't ignore it." Vehra turned away in thought, but she continued. "I don't know what charges would stick, this happening on an Interdicted world. Then there are his duties. Will Popescu work if he thinks we intend to discharge or prosecute him? Could he commit sabotage in reprisal? We have to move cautiously, but we do—"

Vehra faced her. "Is Pitt sedated?"

"He—I've given him heavy analgesics. He's resting, probably sleeping, in some comfort."

"He's not sedated? Not knocked out?"

"There's no medical necessity."

"There's *our* necessity," Vehra said. "We passed this close to calamity. How fortunate we have been."

"Fortunate?"

"Noemi, where do you think Pitt would be now if Michael hadn't done what he did? He'd be off the ship, and we would probably never get him back. You know the regulations about having an intermedia officer. We'd be in violation."

Reyes had to recover her poise. "Captain, the rules have reasonable exceptions, for death or—"

"Desertion? What a fine distinction on our record that would be: the crewman going native. And if Yaru learns of this—" He pointed at Pitt's door. "Anesthetize him. Make sure he doesn't awaken until we're FTL."

"We can take more moderate precautions to keep him on board."

"Like those you took the first time he snuck away to be with . . . her? No, thank you. Handle him, then report to the bridge."

Reyes stood red-eared in his wake, not budging herself until he was out of sight. He was out of line bringing that up . . . except he was captain, and worse, he was right.

Oswald was stirring fitfully in bed, his wounded arm flopping off the side, brushing a computer console stand. Reyes tucked it under the sheet, despite a redoubled flailing. She searched through her medkit, as he began moaning incoherently.

It would have been just as Vehra said, she reflected. Oswald had every contempt for his shipmates, every hatred for modern life, and no reason to remain with either. He was more alien than the Kihoa, more alienated, by his choice. Oswald's mistake would be in thinking life would improve by changing the society in which he was a misfit. Given time for reason, he might realize that himself.

Given present circumstances, it was someone else's decision.

She pressed the hypopatch to his throat. His thrashing and muttering subsided, replaced by a double hiss as he began breathing nasally again. The serenity was artificial, but it was as peaceful as she had ever seen him.

Reyes crept away. One last groan escaped his lips as she reached the threshold. She paused, then dismissed the echo she heard as evidence of her own fatigue. She would have no rest herself for some time.

She went from Oswald's room to the bridge, then straight to Engineering, where she supervised the installation of replacement metafullerene tubules. It was Vehra's make-work, but she let it have its effect, keeping her mind off Oswald.

That job, and the pre-launch checklist she ran with George, ate hours that she barely noticed passing. The only glitches were communications checks. She had to take Oswald's place, and her inexperience brought frustrating delays.

The bridge was nearly full as she finished. "How much longer will that take?" said Vehra.

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"Just finishing now, sir." She kept her eyes off Li, but stole furtive peeks at Popescu. His knuckles were treated, but still scraped raw. His presence on the bridge was unnecessary, something his haughty carriage belied.

Reyes didn't announce completion of her work, except by switching seats to the helm. George gave notice of imminent launch across most of the ship. "Yaru will be disappointed," Reyes finally said.

"The Overlord gave us no command to attend, and you said you gave him no false assurances."

"Yes, sir." So much for diplomacy, though it was very unlikely they would see this world again. Any humans who followed, though, might have a little explaining to do.

The pressure of launch pushed through their inertial compensators. The sky stayed black on the monitors, but the starlight shed its twinkling for a steady shine. The transition was subtle, far different from the spectacle the Kihoa must have witnessed.

Cortelyou slipped into orbit, made half a revolution, then boosted again. They dropped from the plane of the ecliptic, carefully maneuvering into a direct vector for Tutresh. The ship held course a few seconds, then vanished from orbit without even a flash.

"FTL transition complete," George announced. "All engine functions normal."

The subconscious tension broke. Zheng and Mon clasped hands, without cybernetic connection. Popescu leaned back in his chair. Reyes turned off the monitor, useless anyway in transition space, and finally let herself think about sleep.

"Miss Reyes," George said, and she narrowly held off screaming. "You may wish to check on Mister Pitt. He—one moment—he is accessing intermedia, and—"

George's voice disappeared beneath sudden noise. Others winced and covered their ears, but Reyes didn't flinch. The trumpets weren't that loud; they were overreacting. As the passage repeated itself, she found herself supplying the words, lagging a quarter-beat to get the notes right.

"There's a boat that's leavin' soo-oon for New York. . . ."

Vehra was upon her instantly. "Did you help him arrange this?"

"No. No! I just recognize the tune, and the message."

"Message? What does it mean?" Vehra asked several more times, but she never answered.

That overture was a modest opening to the long days ahead. Various nerve-jarring compositions played into the open areas at random times around the clock. The silences were worse, for Oswald might be eavesdropping, ready to inject caustic remarks, then fading away before ripostes could hit home.

The saving grace was that he didn't appear in person. The corollary was that nobody could get to him. George had canceled the crew safety override on his door, and Reyes couldn't convince him to reconsider. "His argument of restored health is persuasive," was one of the many firmly polite parries of her entreaties.

Kayah and Mon withdrew into each other, staying linked almost all the time. Popescu took to shouting obscene insults at intervals, hoping to catch Oswald listening and force a reaction. Vehra and Li simply closeted themselves as much as possible, as everybody did. Private quarters were the one sure refuge.

Oswald kept himself fed by stealth. His tapping told him when areas were quiet, and George did confirm his forays, though confoundingly after the fact. He kept it up for a week, performing his duties from his quarters. He looked to make it all the way to Tutresh without human eyes beholding him.

He sneaked out of his quarters one night, same as other nights. He kept his

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own hours, so getting around his crewmates wasn't hard. Entering the mess took seconds. He gathered some cold meals, turned back, and found Noemi Reyes standing athwart the door.

"You! No, I would have heard you."

"I was very quiet," she said, her visage hardened by dim lighting. "You should have asked George. Something tells me he still talks to you."

Oswald scowled. "I don't talk to him."

"That's not very grateful. He saved your life calling for help."

"My point. And you—" She braced for abuse. "I expect my memory bars back, ma'am. Leave them outside my door."

He walked at her, but she would not yield. "We expect you back on the bridge, mister. I'm tired of supervising every little transmission you download."

"I didn't ask you! Oh, but you do lots of things to me I don't ask."

Reyes absorbed the blow. "I had my orders, and the captain had his reasons. He's within his rights to prevent desertion."

Oswald stood and reddened. Reyes imagined his already swollen nose might explode. "You really threw in with Mike, believing him that way! I guess the jokes will be all over space in a few months. 'Did you hear the one about the Kihoa overlord's daughter?' You people, your whole species is worthless, but the proof really comes as a surprise sometimes!"

"I never said anything about your relationship with—"

He put his face right over hers. "Here's the question you never asked: 'Were you mounting Imsah, Oswald? Or her you?' Here's the answer you never asked for: No!"

He stepped back, depleted, shaking. "That's modern us, all over. The continuum runs straight from casual friend to sex toy. There are notes in between, but I guess most people can't make them out, or won't bother trying. Probably the second."

He left off, and Reyes exploited the silence. "Oswald, I never made assumptions about the two of you." That was a lie, though it didn't feel like one. "What I had was evidence about Imsah's feelings, and no presumption that the difference in species necessarily barred anything."

"See, there it is again. The assumed inevitable conclusion; the prurient insinuation. You won't let it go, and I'm tarred with a lie . . . forever, and . . .?"

He dropped hard into a chair, and struck his fists hard, twice, on the table. "It's not about sex," he said, his avowal stronger than the voice that carried it. "It was never about sex. It's—" An ironic quaver trembled through him. "You could say it's all about soul. That is . . . did you—"

"I understand." She had seen the song title—from Billy Joe with an 'L'.

"Right." He slumped, leaning on his good arm. "She worked so hard, learning her language to a level barely intelligible to other Kihoa. Then, out of nowhere, she's the master, teaching someone else. The barriers fall. She's understood. She's needed. She took such pride—meant so much to her."

He transfixed Reyes. "I never got to say good-bye. I never gave her a decent thank-you. What she missed—doesn't matter, does it? Nothing I can remedy." His head drooped. "Nothing I could ever control."

Reyes stood kneading her hands, thankful his eyes had shifted. "Oswald, I am sorry."

He grunted and put his head on the table. After a long moment, she realized he was falling asleep. "Oswald." She hesitated to shake him: she had been fighting the smell successfully so far. "Oswald."

"Whhrr—wha? What?"

"Who do you think will find you here in the morning?"

That snapped him awake. He started for the door, cautiously passing Reyes, unsure whether she would block him again. "Remember, leave them outside my door."

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Reyes stood for a moment, then realized with horror that she hadn't properly tasked him for the abuses of the last week. She stalked back to her quarters, wondering how to explain that they would have to stake Oswald out all over again.

She didn't need to explain. The harassment ended, though Oswald still would not show himself. Most of the crew took that as the best result possible.

The Tutresh finally acknowledged Pitt's messages, and requested an audience with Captain Vehra when the *Cortelyou* landed. Vehra showed a brave, unavailing veneer. Others mentioned how glad they were he alone was summoned, though not in his presence.

Reyes retreated into solitary indulgences, listening frequently to some of the newest compositions. She began picking at details, criticizing styles, until she willed herself not to spoil the experience. She understood why Oswald condemned those things, but would not endorse his ideas. He was welcome to his theories, and his music—even if she no longer was.

And that was a pity.

The day before planetfall, Oswald walked onto the bridge. He said nothing, and might have heard nothing if there were anything to hear. He slipped a memory bar into a slot on the intermedia console, and sent a tachyon pulse.

Reyes carefully touched the panel she had used the last fortnight to supervise intermedia functions. She glanced over the contents of the bar: English words mixed with short syllables, subscripts, and superscripts. It was his Kihoa lexicon.

She turned to stare at Oswald, who immediately caught her. His eyes were stone-cold, but soon softened into indifference. He got up to leave, but not before hearing a deep sniff. Oswald ignored Popescu's taunt, an inaccurate one today.

"What was he doing?" Michael asked once the door glided shut.

"His duty, mister. Don't you have your own?" Reyes didn't bother to gauge his reaction. She couldn't make herself care that much.

Tutresh swarmed through the landing bay, in and out of *Cortelyou*'s cargo hold. They stood no higher than a meter, with four stubby, scuttling legs and four brawny arms radiating from the compass points of their round, broad bodies. Laborers wore light gray robes; Supervisors had darker diagonal stripes and translator collars.

"Vigilance, worker human. Damaged merchandise is unacceptable."

Popescu's lower lip bled from chewing. Admonishing him was pointless. He couldn't move fast enough to find work before a Laborer did it in his place. He finally found a spot where he wouldn't be submarined every minute, and idled.

Vehra and Reyes did much the same, watching off-loading from the bay floor. A Technician squeezed between them, wearing medium-gray dotted with arcane symbols. It—Tutresh had sexes, but didn't talk about them—commandeered one organic mainframe from a Laborer, and knelt down to study it.

Reyes covered a laugh at the spectacle of a kneeling Tutresh. "Stop that," Vehra told her. "The Proxy could be along any time. What if it sees you—ohhh!"

The bustle had stopped. All the Tutresh were now kneeling. Vehra nearly fainted with anxiety, but Reyes didn't react to the spectacle. A Tutresh stood imperiously in the doorway. It wore thick black and white stripes, which from above would appear as concentric circles. It stepped forward—and a duplicate followed.

The first advanced until his lower body jogged Vehra in the shin. An artificial voice spoke over its natural clicks, pops, and hisses. "Captain, the Philosophers will consult with you. Take my path."

"Yes, Proxy, but what of your companion?"

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The first Proxy halted. Tutresh had full-circle sight from the sense cluster atop their heads, so it was axiomatically looking back at the dawdling Vehra. The captain fidgeted, then followed, his curiosity unsatisfied.

The second Proxy drew toward Reyes. "Captain Minor, where is your Speaker?"

'Speaker' meant intermedia: it wanted Pitt. "Popescu, go get Mister Pitt. Yes, I think they can spare you." She sternly watched him go inside. "He is coming, Proxy." She worked to contain her curiosity, as successfully as Vehra. "Proxy, why do you want our Speaker?"

"I do not. The Philosophers do."

"Very well, why do they want him?"

"To consult."

"Yes. I understand. Why do they want to consult?"

"Your Speaker reported the damage we caused. Your Speaker provided knowledge for our Scholars. Your Speaker will help the Philosophers choose its reward."

Before Reyes could react, Oswald loped out of the cargo bay. The Proxy made for him, freezing him where he stood. "Speaker, the Philosophers will consult with you. Take my path."

Reyes's reassuring nod was all that moved Oswald. He followed like a child to the principal's office. Reyes was already cogitating before he departed.

Thanking Oswald for his lexicon, fine, but what damage did the Tutresh cause? Did a Laborer drop something here? How would Oswald have reported it? This was more than translator imprecision at work.

She dodged Tutresh and Popescu to enter the bay. "George, are any of the engineers available? Summon one to oversee things here."

"I am summoning Mister Zheng. Will you now be unavailable?"

"For a while. I'm going to the Tower."

The Philosophers' Tower was an ugly, colorless column of metal, devoid of aesthetics, consecrated to intellect. Its door was the lone opening in the building, symbolic of the single path to reason. Reyes battled down self-consciousness as she stepped a few meters through that door. Anyone leaving would now have to come to her.

She was in the Reflection Room, the entire lobby walled in mirrors. The Tutresh there, mostly in darker raiments, were multiplied to frightening numbers. She never shook the fear that they would charge her *en masse* for violating their sanctum. They didn't think that way, though, and they acted on thought—almost always.

It was not long, less than an hour, before she sighted Captain Vehra exiting a lift. He looked deflated, and his skin was sallow. His color alteration didn't suit him, not in this mood.

"What happened, Captain?" If he was here unescorted and unrestrained, how bad could it be?

"Cancellation," he muttered, shaking his head.

"Captain?"

He came to and noticed her. "Our violations of Interdiction Major. I said we couldn't help it. The Philosophers didn't care. They said their fault in our engine failure canceled out our infractions, but nothing more. No restitution due to us, no boon. Nothing."

"Captain, wait. Our engine failure was their fault?"

"They say so. They had a ship suffer similar damage the same time ours did. They concluded it was a collision of opposing tachyon wakes."

"They finally admit it, then."

Vehra's jaw tightened, as they came into outside sunlight. "They did. They swept away their old assurances without a thought, assurances I took for granted, and what happens? They call it even, because we bent rules we wouldn't have had to if they hadn't marooned us. Justice, they say, and they know I'll swallow it. I have to."

"I should have known. The other

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Proxy mentioned the damage when he came for Pitt."

"Pitt? They can take Pitt. If the Philosophers let him loose, you can have the privilege of firing him. I'm going to the hotel."

He left Reyes behind without another thought. She stood in the street, mind awhirl, then hurried back to the Tower. Her haste served her, as she met Oswald at the door.

"Oswald?" He was expressionless, as if nothing had occurred. "Congratulations are in order . . . aren't they?" He grunted neutrally. "Weren't the Philosophers going to reward you?"

"They did," he said, resuming his gait. "I asked for the opportunity to return to Kuess someday, and they agreed. They'll transport me and everything."

Reyes was becoming inured to the cascade of bombshells. "You're leaving, then," she said, downplaying any relief she felt.

"Not now! I said 'someday'. It's open-ended; I can redeem it when I choose. Are you surprised? Disappointed?"

"I didn't say that." Was she?

"That wasn't my question. I know what you'd all assume if I left today. I can wait."

"You don't have to go by what we think," Reyes said, hoping to get to Vehra's pronouncement obliquely.

"Yes I do. Besides, I'm not a quitter. I won't leave." He frowned. "I was tempted, after Poopoo and Leaky had their fun, but they won't get the satisfaction. With this open offer, I can stand them better. I'll have somewhere else to go, so staying will mean more. They'll know that.

"It's pride, too. Everyone hates my guts, which is fine by me, but they know I perform. If I weren't so good, Vehra would've arranged an airlock accident long ago, and filled my slot with someone—" He snorted. "—suiting his needs."

The silence that followed got to Oswald first. "What are you going to say?"

Was her appearance that obvious? Reyes wished her next words were. She flailed momentarily, then latched onto a stalling tactic. "The Tutresh are transporting you? I didn't think you appreciated their influence on humans."

Oswald goggled at her. "You don't understand, and I'm not surprised. Can't you see? It wasn't their actions, it was our reactions. Aliens didn't wreck human culture; we did." He watched in mild condescension as that sank in. "Now you've got something else to say."

"No." With that word out, her course was clear. "Not to you; to the captain."

Haven Hotel was human-built and operated, a refuge of familiarity in lands most alien. Vehra had rented one of the best rooms, and settled down fast. Reyes found him in a silken burgundy kimono, apparently awaiting some pampering. She tried not to imagine what kind, or by whom.

"Done already? Good." He shambled toward the nightstand. "I've already found some prospects to fill the job. Always a few transients—"

"I have other business to discuss."

Vehra left the notescreen on the table. "What now? Trouble with the Tutresh?"

"No, sir." Reyes clasped her hand behind her back. "Will you make me captain of the *Cortelyou*?"

Vehra simpered. "What, now?" Her rigid countenance answered that question. "Whatever for, Noemi?"

"Because I want it. Because you can't fault my technical aptitude or command ability. Also, because you prefer other pursuits, ones which don't require you to command the *Cortelyou*, just to own it."

"I like command. I enjoy running the ship."

That broke her reserve. "You don't. You enjoy giving orders. I do the work. I'm executive officer, I double at helm, triple as ship's nurse, quadruple in crew relations, for the little good it does, and quintuple anywhere you need a warm body. Almost anywhere, that is."

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"So you're offering to sextuple at insubordination? No, I know what this is about. Crew relations, you said. You're taking Pitt's side, aren't you?"

"That isn't the issue."

"Really? If I gave you the captaincy, would you hire him back?"

"That would be my command decision."

"That isn't the issue," he parroted. "You're making this demand to keep Pitt on board. What possible motive can you have?"

She hesitated, but his demand for synthesis spurred her. "Understanding. I think I comprehend him better. His hostility doesn't come from pure anarchic hate. He has motives; he has ideas. I disagree with them, but they exist, and they're comprehensible. There's room for reason within him. I wonder about that with us."

"Noemi, don't bring up that tussle in the mess again."

"Why not? Popescu went farther than Pitt ever did, but you're shucking Pitt because Popescu never wounded you personally."

"It was more than wounding. He flagrantly disobeyed orders on Kuess."

"Probably with good reason. That's one thing you can't deny, Captain. Pitt does his job well. For that alone, I'd have him aboard my ship. The rest—I think he can be turned around. I'm willing to try."

Vehra's face was quizzical, but soon his lip began curling. "Willing to put some personal effort into it, I'll wager. I always knew you and Michael were a sham together."

Reyes darkened. "I'll revise my statement. I disagree with *most* of Pitt's ideas." She watched Vehra's sneer fold. "Will you give me command of the *Cortelyou*?"

"Out of the question. It's my ship; I'll run it."

"Then what's your price?" she asked. His head snapped, though he was looking right at her. "I have savings. I can give you a down payment, arrange a loan. We can close today."

"You don't have that much money, and I don't care to sell. If that is the end of your business, you are excused. Oh, and do remember to speak to Pitt. I'll handle the new hiring myself."

Reyes stood fast. "You should see to Pitt yourself. You are his boss, after all."

Vehra had faced the other way, and didn't bother looking around. "Always stubborn. No matter. I informed George of the dismissal. If Pitt shows himself, he'll be told." He slipped into the bathroom, his voice still carrying. "Thank you, Noemi. That will be all."

Reyes had walked back slowly, chary of the dreadful scene she feared she would find. *Cortelyou* looked peaceful enough outside, its cargo unloaded, its hold shut. She keyed the portal, bracing herself, but it was calm within.

"George, did Oswald return to the ship?"

"He did, and has since departed. Are you aware that Captain Vehra—?"

"Fired him, yes." She boarded the lift. "Crew level, please. How did he react?"

"Very oddly, miss."

She braced herself. "How oddly?"

"He said nothing. He packed his belongings and left."

The lift doors opened, and she walked straight to Oswald's room. It opened, itself a novelty, and she was amazed to find it immaculate. The floor was bare, the furniture ordered, and the bed passably made. Ship's interfaces were neatly arrayed. His personal computer was gone.

"Have you any information about a replacement intermedia officer, Miss Reyes?"

She took one last look around. "Nothing but guesses, George."

She nearly stepped on it outside her quarters. It was a small memory bar tucked into a sleeve, the initials 'NR'

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written on the label. Reyes scooped it up and locked the door behind her.

No doubt who left it, but what was it? She slipped it into a port below her console. A single file listing wrote itself out. She read the title, and even as she said to herself, "That's it?" she tapped the 'Play' box.

The music began, a large, obsolete orchestra backing up a powerful baritone. It was the final song from *Porgy and Bess*, full of hope in the midst of sorrow, the prelude to a long journey.

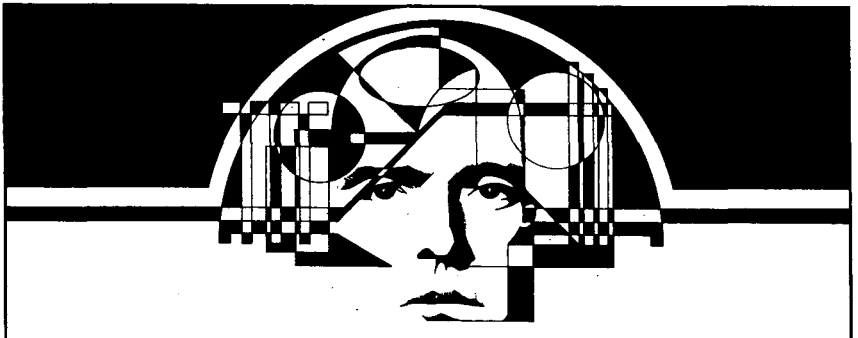
It made perfect sense . . . but not without its irony. Porgy's destination was New York, the hub of modernity, the great equivocal Wonderland. Oswald's destination was the very opposite. Did he imply the same ambiguities? If so, it changed nothing. He, too, was committed, come what may.

Reyes let the music run to its climax, then sat in the silence. Her impassive face brightened as a brief, furious debate ended within her. She went to her closet, and threw a large trunk onto her bed. The memory bar was the first thing that went in.

"Miss Reyes, do you have plans I am unaware of?"

Noemi smiled at George's guilelessness. She had plans: different plans, but the same. "George—" she started. She could make a grand speech, but that title said it all.

"I'm on my way." ■



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Don't miss *Analog* and *Asimov's* co-hosted chats with the Sci-fi Channel at **www.scifi.com/chat** (or link to the chats via our home page **www.analogsf.com**). Chats will be moderated by **Gardner Dozois.**

Bruce Sterling	November 24, 1998	@ 9:00 p.m. EST
Maureen McHugh	December 8, 1998	@ 9:00 p.m. EST
James Patrick Kelly	December 22, 1998	@ 9:00 p.m. EST

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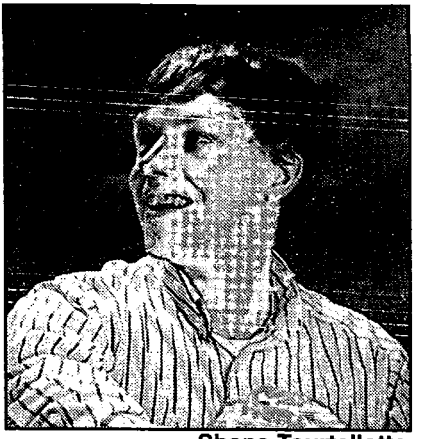
BIOLOG Jay Kay Klein

Shane Tourtellotte's path toward becoming a full-time writer is fairly typical, but he supposes his life's twists and turns must not be up to the usual standards. Since *Analog* stories cover the range of all space/time plus human and alien psychologies, not only do authors require a diverse range of experiences and accomplishments, but *Analog* requires a diverse set of writers. He says, also, "It's tough to write a biographical sketch about someone who has no life." This was exactly the attitude of Isaac Asimov, who managed to publish three large volumes of autobiography and be elected to the Explorer's club. He had scouted the universe in his mind and brought back its wonders to those who had merely traversed mountains, deserts, and jungles.

In another way, Shane emulates Dr. Asimov, who grew up in New York and went back after ranging only as far as Boston and Philadelphia for some years. Born in Westfield, NJ, just across the Hudson from New York, Shane moved five times in ten years, going only as far as the outskirts of Philadelphia, upstate New York, and Maine, before returning near his starting place, to Rutherford, NJ. Sharing another, virtually universal trait among *Analog* writers, Shane won academic honors throughout high school, including membership in the National Honor Society and a National Merit Scholarship.

From that point, two pathways toward *Analog* authorship diverge—one leading towards university degrees and one towards intensive self-education. Shane started in one direction, studying Mechanical Engineering at Cornell for two years, then went on to an assortment of jobs, which now provide time to write. He continues his lifelong passion for reading, doing on his own what tutors direct in Oxford and Cambridge. As a boy, his parents nourished his appetite for books. Curiosity and self-learning mark all *Analog* writers, who transcend limited scholastic curricula. There are only learned men and women among SF writers, but in academia there are professors who are ignoramuses by *Analog* standards.



Shane Tourtellotte

As a child of the space age, Shane's early interest was in astronomy and spaceflight. The Apollo missions made a profound impression when Armstrong took his famous steps before Shane had taken any at all. He grew up thinking of space as a place where we could, should, and would go to explore the unknown. Acquaintance with SF came, inevitably considering his place of birth, through *Star Trek* reruns and *Star Wars* seen at eight. Books came later, the first

(continued on p. 138)

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THE ALTERNATE VIEW John G. Cramer

MASSIVE NEUTRINOS

This column is about recent evidence from the Super Kamiokande detector in Japan indicating that at least one of the three known neutrino flavors, the mu-neutrino, has a nonzero rest mass. To put this result in the proper context, I'll briefly review parts of the standard model of particle physics.

The basic building blocks of the universe come in two particle types: half-integer spin "fermions" (spin = 1/2) and integer-spin "bosons" (spin = 0, 1, or 2). (For a discussion of these, see my column on Bose-Einstein condensation in the March 1996 issue of *Analog*.) The boson particles (gluon, Z^0, W^*, and photon) are "mediating particles" that create the forces (strong, weak, electromagnetic) which act between the fermion particles. Matter is therefore a collection of fermions held together by bosons.

The spin 1/2 fermion particles in the standard model also come in two types: quarks and leptons. The six quarks (down, up, strange, charmed, bottom, top) have relatively large masses, fractional electric charges of ±1/3 or ±2/3, and respond to the strong interaction, the force that binds quarks into composite particles (protons, mesons, etc.) and also binds neutrons and protons to form nuclei.

The six leptons do not respond to the strong interaction and come in two types. The three charged leptons (electron, mu, and tau, or e, μ, and τ) have charges of ±1, and rest masses of 0.511 MeV, 106 MeV, and 1,777 MeV, respectively. The three corresponding uncharged leptons are called neutrinos (ν_e, ν_μ, and ν_τ) and have rest masses which are known to be very small or perhaps zero.

In this column, we focus on the question of whether neutrinos have a nonzero rest mass. While there are good reasons to believe that gluons and photons have masses of exactly zero, there is no known reason why neutrinos should have exactly zero mass. If they do not, then they can engage in a peculiar behavior called "oscillation," in which they can switch identities as they travel. Consider, for example, two of the neutrino flavors (e.g. ν_μ and ν_τ) that have precisely the same spin (1/2) and the same charge (0) but differing rest masses. Can these two quantum states be distinguished on the basis external observations that do not include mass measurement? *Answer*: no, they cannot.

When two quantum states cannot be distinguished, a peculiar thing happens; they *mix* to form two new states of matter that *are* distinguishable. In the case of two neutrino flavors, the mixing produces amplitudes for two states that are created together each time a neutrino is emitted. The two states have different rest masses and, for a given kinetic energy, travel with slightly different speeds. Because of the speed difference, they change their relative phasing along the path and interfere so as to cancel or reinforce depending on position. The result is an "oscillation" in which the emitted neutrino appears at some points along its path to be a pure mu-neutrino (ν_μ) and at other points to be a pure tau-neutrino (ν_τ). This is called a *neutrino*

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oscillation, and this is what the experimentalists at the Super Kamiokande detector in Japan appear to have observed.

Historically, the original Kamiokande detector was built to search for an effect that has not been observed and may not exist: the decay of the proton. (See my Alternate View column on proton decay in the July 1984 *Analog.*) In the early 1980s it was expected, on the basis of certain "grand-unified theories" (GUTs) fashionable at the time, that a proton might decay into lighter particles (e.g., $e^+ + \pi^0$) with a half-life of about 10^{32} years, a value short enough to be measurable. The Japanese built a large water-filled detector deep underground in a mine, seeking to observe such decays, and they have so far failed to do so (as have a number of other similar experiments around the world). The GUTs giving short half-life predictions for proton decay have now been falsified by experiment, and it is now clear that the proton half-life is 10^{33} years or more.

However, the Japanese investment is the Kamiokande detector was saved by a cosmic accident, the arrival in February 1987 of light and neutrinos from the Large Magellanic Cloud, where an obscure star named Sanduleak -69°202 had exploded 160,000 years earlier to produce Supernova-1987A. (See my column in the December 1987 issue of *Analog.*) Kamiokande, which happened to be operating at the right time (several similar detectors were off-line then) detected 11 neutrino events from SN-1987A. This observation made a very important contribution to the brand-new science of neutrino astrophysics.

Based on this success, the Japanese and their American collaborators expanded the old detector with a larger volume of water and the addition of many new photomultiplier light-detectors. The new detector Super Kamiokande, is designed to detect neutrinos from the Sun, from supernovas, and from cosmic rays. Neutrinos interacting with the water are converted to charged particles (e or μ leptons). These make Cerenkov light flashes that are recorded by the photomultipliers. The pattern and intensity of the detected light allows reconstruction of the energy and direction of the initial neutrino, and can distinguish electron-neutrinos (ν_e) from mu-neutrinos (ν_μ). Super Kamiokande has now been operating for about a year and is beginning to produce results.

One of the new results bears on an old puzzle which is called the cosmic ray neutrino discrepancy. The top of our atmosphere is continually bombarded with cosmic rays, particles (primarily protons, electrons, and gamma rays) having kinetic energies much larger than can be produced with the large accelerators at FermiLab and CERN. These particles hit the top of the atmosphere, producing a "shower" of multiple interactions as the primaries and their reaction products repeatedly collide with nitrogen and oxygen nuclei of the atmosphere. These energetic collisions produce a large number of charged pi-mesons ($\pi^\pm$). The pi-meson, a combination of a quark and anti-quark in tight orbit, decays in its own rest frame in about 2×10^{-8} seconds to a mu-lepton (μ) and a mu-neutrino (ν_μ). The mu-lepton in turn decays in its own rest frame in about 2×10^{-6} seconds to an electron, an electron-neutrino (ν_e), and a mu-neutrino (ν_μ). Therefore, the Earth's upper atmosphere is a source of energetic neutrinos, and there should be about two mu-neutrinos for every electron neutrino because of the $\pi^\pm\ \mu^\pm\ e^\pm$ decay chain. However, careful ground-based measurements of the ratio of mu-neutrinos to electron neutrinos indicates that the ratio is about 1:1 rather than 2:1. Somehow, there are less mu-neutrinos than expected. This has been an unsolved astrophysics problem for many years.

Now this puzzle appears to have been solved. The Super Kamiokande detector can observe neutrinos coming from the full sphere formed by the top of the

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Earth's atmosphere, from neutrinos produced directly overhead to those produced on the far side of the Earth. The far-side neutrinos must pass completely through the Earth to reach the detector, which is only possible because of the very small probability that neutrinos will interact with matter.

Super Kamiokande sees that for electron-neutrinos, the probability of production is about the same for all points in the upper atmosphere. However, for mu-neutrinos a "disappearance effect" is observed. As the point of origin moves from the zenith directly overhead to the nadir (straight down), fewer and fewer mu-neutrinos reach the detector. The reduction factor depends directly on the increasing path length as the production point moves from zenith to nadir and the neutrinos have to travel farther and farther to the detector.

The Super Kamiokande group interprets the increasing disappearance of mu-neutrinos with increasing path length as evidence for neutrino oscillations. Due to the oscillation process, the mu-neutrinos are transformed into some other flavor of neutrinos that is not detected. Since they do not see the electron-neutrinos increase as the mu-neutrinos disappear, they conclude that the oscillation is not between n_e and n_μ. They consider two remaining possibilities: (1) an oscillation between n_μ and n_τ and (2) an oscillation between n_μ and hypothetical "sterile" neutrinos which have no interactions with matter.

The Super Kamiokande detector also observed, with poorer statistics, neutrino interactions that produce p^0 mesons in the detector. This "neutral-current" process should be equally strong for all three flavors of neutrinos (but zero for sterile neutrinos). It shows no evidence of oscillation behavior, making (1) the more likely scenario. Therefore, the most plausible explanation of the new data is that n_μ and n_τ neutrinos have a very small mass difference, with a mass-squared difference $\Delta m^2 = 2.2 \times 10^{-3}$ eV^2. This mass difference is consistent with the observed oscillations.

What are the implications of this observation? Massive neutrinos are one of the leading "hot dark matter" candidates, possible unobserved massive particles needed to explain several cosmology problems. Among these problems are the large-scale distribution of galaxies and galactic clusters and the high velocities of stars in galactic haloes. Also, Big Bang theorists would like to have a "critical" universe that is precisely balanced between the positive kinetic energy of Hubble expansion and the negative potential energy of gravitational attraction. Satisfying these conditions would require that the most massive of the neutrinos, probably the n_τ, to have mass around 1 eV, with the other neutrinos (n_e and n_μ) having considerably smaller mass. Although the numbers are not yet completely pinned down, the Super Kamiokande results make a contribution to such a scenario.

There is, of course, another neutrino problem. With solar neutrino detectors like Super Kamiokande we consistently detect only about 30% of the electron-neutrinos that we expect from fusion processes in the Sun. What does this new result have to say about the missing solar neutrinos? As mentioned above, electron-neutrinos show no evidence of disappearance or oscillation. This suggests that the mass difference between n_e and n_μ is much smaller than between n_μ and n_τ.

The current view is that the solar electron-neutrinos disappear by oscillating into mu-neutrinos due to the MSW effect, arising from the electron-neutrino's long passage through the matter of the solar interior on their way out. A neutrino mass spectrum in which the tau-neutrino had a mass of around .05 eV, the mu-neutrino had a mass of perhaps .005 eV, and the electron-neutrino had a mass of perhaps 10^{-5} eV would probably permit an explanation of both the cosmic-ray and the solar neutrino puzzles. How-

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ever, a tau-neutrino mass of .05 eV is a rather low value for explaining the hot dark matter needed to make some cosmological models work.

This leaves one remaining neutrino puzzle, the negative mass-squared values for the electron-neutrino that have been observed by six different studies of the end point of the tritium beta decay, as discussed in my previous Alternate View columns in the September 1992 and October 1993 issues of *Analog*. These results suggest the electron neutrino might have an imaginary mass with an absolute value of perhaps 12 eV (i.e., it might be a tachyon).

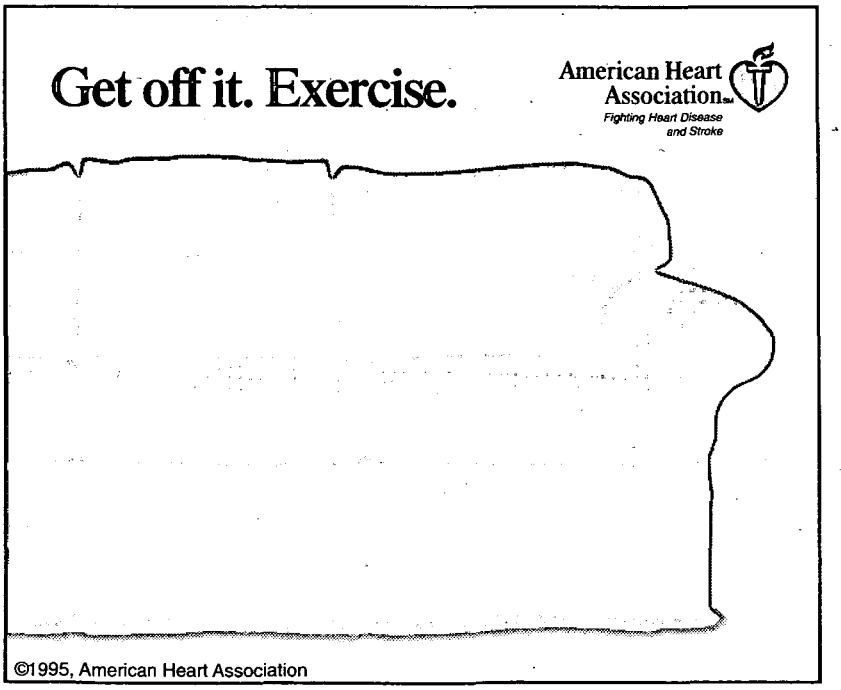
Has this possibility been eliminated by the new results? I don't think so. However, the tachyon neutrino hypothesis is sufficiently unpopular in the physics community that a neutrino mass spectrum with a tacyonic electron neutrino is not likely to be considered seriously as one of the alternatives, unless the new data forces attention in that direction.

In any case, we know something this year that we did not know last year: *neutrinos have mass*. They are not zero-mass particles like the photon and the gluon. And they may represent at least a part of the dark matter that has been puzzling cosmologists and astrophysicists for the past decade. □

AV Columns On-line: Electronic reprints of 90 or so past "The Alternate View" columns by John G. Cramer from *Analog* are available on-line on WorldWideWeb at the URL: http://www.npl.washington.edu/av .

Reference

"Evidence for oscillation of atmospheric neutrinos," The Super-Kamiokande Collaboration, Y. Fukuda, *et al.*, submitted to Physics Letters, preprint hep-ex/9807003 in the LANL Archive, (July 3, 1998).



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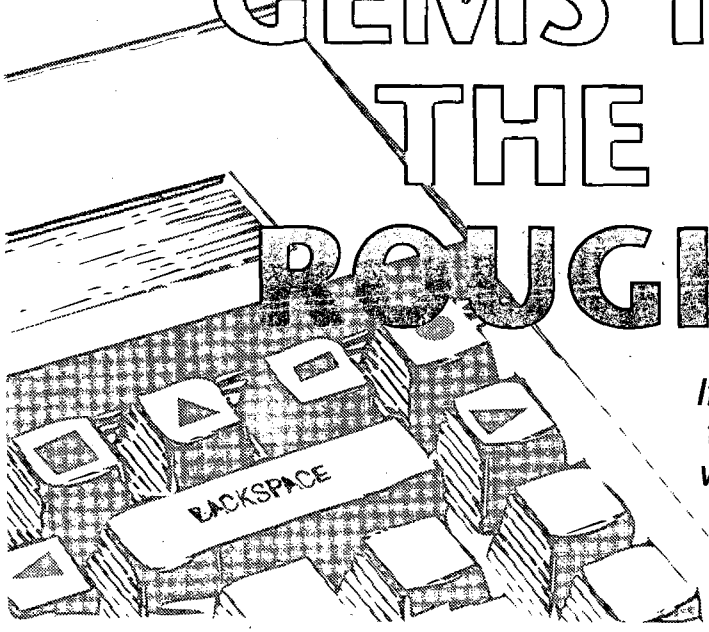
Jerry Oltion

GEMS IN THE ROUGH



If you had it to do over, would you?

Derek felt a moment of Déjà New just before the doorbell rang. A moment of disorientation, a split second wherein he felt two sets of memories crowding his mind before reality asserted itself again. He got up from the couch where he had been reading *Rolling Stone*, switched off the magazine and draped it over the arm of the couch, and went to answer the door. Déjà New before the date even started wasn't a good sign. Especially on a first date. It meant something had gone so disastrously wrong that he and Gardenia had decided to backspace and try it again.

Except he had no memory of the faux pas. Usually when you backspaced you remembered why you'd done it, at least until you'd had a chance to make whatever change you'd gone back for. Gardenia must have done it on her own. But was it his mistake or hers she'd come back to undo? He had no idea. It made him decidedly uncomfortable. Did he have spinach between his teeth? Had he left his fly open? Had he said something offensive? How could he fix it if he didn't know what it was?

He opened the door. Gardenia stood there, her blonde hair curling down past her oval face to touch her shoulders. She was dressed in iridescent blue bodypaint that shimmered with flashes of green and yellow when she moved. It showed off her designer physique to perfection, and as Derek said, "Come in," and stood aside for her, he wondered if he had lost control and molested her right there in the living room.

Except in cases of date rape it was usually considered the man's duty to backspace and undo it, to spare the woman the unpleasant memory.

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Maybe she had raped him? Or perhaps she was a murderess, and now she would spend the rest of the evening telling him in detail how she had killed him the first time around. He hated dates like that. If that's what had happened, he would backspace a few hours and cancel the whole date, claiming a headache.

He wished he could just ask her, but most people considered that a worse breach of etiquette than murder. Derek didn't share their opinion, but you were supposed to pretend you hadn't noticed the moment of discontinuity when someone you were with backspaced, so he merely smiled and said, "You look lovely."

She did, too. She always looked nice at the bank where they both worked, but she never dressed like this. Wendy, their supervisor, would never have allowed it. Gardenia would have outclassed her in a potato sack—a fact that no doubt fueled Wendy's hostility—but in bodypaint Gardenia would have made her look even more like the witch she was.

Derek was glad he hadn't elected to wear paint; he took good care of himself, but he would never match her attractiveness either, not even in a gay bar. As it was, his black and white casual suit would blend in with everyone else's and allow people to admire her without distraction.

Now that she was in the room with him, he smelled the flowery aroma of her perfume. Apple blossoms? He couldn't tell.

"So where are we going?" she asked.

They had agreed to go out for dinner when he'd asked her that morning, but they had never settled on a place. Now it looked as if that decision was up to him. He'd been imagining someplace dimly lit and intimate, but a woman didn't dress like that to go sit in the dark. "How about Thai food?" he asked. "I know a place with a rooftop garden."

She narrowed her eyes. "Thai food? I've never tried it."

"Then you should." He held out his hand and led her through his apartment and up the stairs to the roof, where they watched the sunset for a few minutes before he hailed an aircab.

At the restaurant the headwaiter took one look at Gardenia and seated them at a table on the edge of the building, where everyone in the passing cars could see her and know that Thai Heaven was where the beautiful people dined. The weather attenuation field let just a whisper of sound through from the traffic, and only enough of a breeze to waft her hair gently into the air from time to time.

The menus were six pages long. "Pad Thai is the most traditional dish," Derek said as he scrolled through with the thumb slide in the left margin, "but I've never had a bad meal here no matter what I pick."

"That's encouraging," Gardenia replied. She looked at the choices for a minute. "Have you ever had the Three Kings Crown?"

Derek scanned through his menu for it, found it under "specialties" with four stars beside it. "Never had the courage," he admitted. "You want to try it?"

"Sure," she said. But a moment later Derek felt another wave of Déjà New and she said, "On second thought, let's not. It's too—well, it's probably too spicy."

Derek looked at her glittering green eyes as she spoke, and she glanced away. "Don't 'probably' me," he said, smiling to show her he was more amused than mad. "You backspaced just now, didn't you?"

She blushed. Just her cheeks—her bodypaint didn't allow him to see more. "Um . . . yes. I'm sorry, but my lips were *hot*, and . . ."

"This is a problem?" he asked, and she blushed even redder.

"I suppose I should have asked you first," she said, "but I didn't think you'd mind."

"It's all right." He looked down at

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his menu again, wondering how long she had let the peppers burn before she'd excused herself from the table on the pretext of going to the bathroom and used the restaurant's backspacer instead. But his curiosity faded quickly, like a dream after a person wakes. It was hard to focus on a lost reality after the new one asserted itself. Only the person who went back remembered the way things were before, and even their memory faded over time.

No hot entrees, though. He remembered that much.

He played it safe and ordered Prig King. She ordered Massaman, then changed her mind at the last moment and got the Pad Thai instead.

"Was Massaman too hot, too?" he asked when the waiter left.

She shook her head. "No, it just wasn't what I wanted."

"Ah." He hadn't felt any more discontinuities, so maybe that's all it had been.

He looked down through the passing traffic to the grassy street below, where pedestrians walked hand-in-hand in the last light of evening. A couple of kids were chasing a stray dog. The dog barked at them, staying just out of reach until one of the kids picked up a stick and swung it in a wide arc, but instead of hitting the dog he wound up hitting his companion.

"Ow," said Derek, wincing in sympathetic pain.

"What?" asked Gardenia.

He pointed. "One of those kids down there just whacked the other one with a stick by accident."

"Oh. Then we're on borrowed time." She grinned at him. "Got any thirty-second fantasies you want to try out?"

He looked at her painted curves, at her mischievous smile. "Is that a trick question? But there's really not much point, is there? We won't remember it. Besides, it looks like they're not going to backspace." He nodded toward the kids, who were chasing the dog again.

"Wow," said Gardenia. "I sure would have."

"I gather you backspace a lot."

She shrugged. "Not as much as some people. But I don't see any reason to live with a bruise when it's so easy to go back and eliminate it."

"Hmm." He picked up his fork and twirled it in his fingers. "I guess for me it depends on how bad the bruise is. I've actually still got a couple of scars from my childhood. Even after the backspacer was invented, I didn't figure it was worth going back that far to fix stuff that had already healed."

Gardenia's eyes widened. "You have *scars*?"

"Yep."

"Where?"

"Let's just say if I showed them to you here, we'd *have* to backspace or get kicked out of the restaurant."

"Oh."

The waiter came back with their drinks, sweet ice tea with cream swirling through it. Derek mixed his up with his straw until the tea resembled rusty water; Gardenia held hers carefully in her hands, watching the cream drift downward like jellyfish tendrils slowly invading the bottom of the glass.

"So how bad does something have to be before you'll backspace?" she asked.

He shrugged. "Not that bad, really. Just last week I caught a cold at a party, so I went back and took an immune booster before I got there."

"You still went to the party?" She set her glass down. "I'd have found one that didn't have sick people."

"It was my sister's party. I didn't want to offend her."

"Oh." Gardenia smiled knowingly. "Family is still the one thing you can't change, isn't it? My father drives me crazy sometimes, but no matter how many times I go back and try to fix things, he still manages to put a blotch on an otherwise perfect life."

"Is that what you're trying to do?" Derek asked. "Make a perfect life?"

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She looked at him with a puzzled expression. "Of course I am. Doesn't everyone? What else is the backspacer for?"

The waiter brought their food, the aroma of curry and peanut sauce filling the air. As they piled rice and noodles and chicken and vegetables on their plates, Derek said, "I don't know if it's *for* anything in particular. I doubt if the guy who invented it figured on a tenth of the use it gets. He probably thought he was saving lives."

"He is," Gardenia said. "He's saved us from having to live with all the rotten luck and bad memories that people used to be stuck with."

Derek watched the way she moved when she picked up the plate of Pad Thai. He could see every muscle at work. With only a layer of iridescent paint between her and the world, she was as good as naked. So were half a dozen other people in the restaurant. They were all slender and good-looking, and none of them considered the consequences of being miles away from home with nothing to protect them from the weather or from other people. If something went wrong, they would go back and fix it.

"I've got to admit," he said, "I like the way it's made people relax."

Gardenia flinched, then looked away.

"What?" he asked. "I said something wrong, didn't I?"

"No, it's . . . well . . . I just wouldn't call it 'relaxed'."

"No?"

She hesitated, then took a deep breath and plunged ahead like a swimmer into icy water. "I worry about everything. Is my hair right? Is my paint thin enough? Is it too thin? Did I say something stupid? Could I have said something more intelligent? Now that I've got the chance to go back and re-do everything, it feels like I'm obligated to do it. It's not easy being perfect, you know."

"Actually, I don't know," he said. "I've never tried."

"You should."

He looked down at his plate, for a moment seeing not noodles and rice but a writhing mass of worms. He looked back up at Gardenia. "Sorry. I'm getting too personal for a first date. And you're answering because you plan to hit the backspacer the first chance you get and make a polite apology when I asked you out this morning. Right?"

She made a little shrug. "We don't have to undo the whole date. I kind of like you. We could still have a lot of fun together."

He smiled. "Thanks. Somehow that means more coming from someone on borrowed time than it would if we were still on the main track."

She laughed. "Isn't it strange how a person can only say what they really mean when it doesn't matter?"

"Yeah."

She picked up her fork. "As long as we're backing up, let's check the food first and see if we want to reorder."

"Sure." Derek tasted the Pad Thai. Thai Heaven's version was light and delicate, the eggs and noodles and bean sprouts blending smoothly into one wonderful flavor. The Prig King was stronger, the peanut sauce and the curry fighting for dominance but neither quite overpowering the other.

"It's perfect," Gardenia said.

"You use that like a technical term."

She tossed her hair back away from her forehead with a casual flip of her head. "It is."

"Tell you what," he said. "Let's do something really crazy. Let's finish the meal before we backspace. In fact, let's finish the whole night first. Linear time all the way to the end. Just for curiosity's sake. If we're going to backspace at the end of it anyway, let's see what happens when it doesn't matter."

Gardenia colored slightly, no doubt thinking of all the ways the evening might progress. "All right," she said. She picked up a forkful of noodles and brought them to her mouth, but one

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slithered off her fork at just the wrong moment and landed on her left breast, where it draped itself over her nipple and dangled there like an organic pasty while she gasped, "Oh no! You've got to let me undo that."

"Nope." He grinned and reached across the table to remove the noodle, which he slurped slowly into his mouth while he wiggled his eyebrows lasciviously at her.

"But—"

"No revisions, not for the entire night."

"But I've got sauce on my boob!"

"Want me to lick it off?"

"We'll get kicked out of the restaurant."

"Good point. Better use your napkin."

She did, wiping off some of the iridescent paint in the process. Bodypaint normally wouldn't come off with casual rubbing, but something in the sauce must have acted like a natural solvent.

Her pink nipple seemed all the more red peeking through the field of blue. "Well," she said, "this is certainly turning out to be an interesting date, that's for sure."

"I spent months choreographing it."

She looked up at him so quickly her hair flew forward for a second before falling back down around her shoulders. "What? How could you—?"

"I'm kidding."

"Oh." She took another bite. "You sure know how to keep a woman off guard."

"Natural talent," he said. They ate in silence for a few minutes before he asked, "So how many times have you murdered Wendy?" Wendy delighted in making her workers miserable with stupid new rules; the tellers and loan officers sometimes took out their frustrations the old-fashioned way.

Gardenia rolled her eyes and swallowed. "Who knows? The memories fade. But I'm pretty sure I poisoned her coffee last week, and I sort of remember pushing her down the stairs a month or so ago. How about you?"

"Shotgun," he said. "About three months ago. Marched into her office and let her have it right in the chest. At least that's how I remember it. Funny thing, nobody backspaced for over an hour afterward."

"At the *bank*?" she said incredulously. "We kept working? Why? We'd just have to do it over again."

"I think we were just so happy to have her out of our hair that we were willing to put in the extra time before we brought her back. But I don't know for sure. Like you said, the memories fade."

She stirred her tea and drank, then said, "I've always wondered why she stays at a job where everyone hates her."

"Same reason we stay at a job we hate, I suppose," he replied. "No amount of backspacing will find us a free lunch. And even with Wendy, the bank isn't really that bad."

"I suppose not," she said. "I keep thinking I ought to go back and try for a better job, but I've put so much work into the rest of my life I'd hate to wipe it all out just for that."

Derek knew what she meant. The psychological toll of a major edit could be extreme. Reworking the bad times was one thing, but losing all the good times that went with them was too large a price for most people to pay. And paradoxically enough, the more a person fine-tuned their day-to-day life, the less likely they were to throw the entire thing to the winds and start over.

Gardenia, he suspected, would stay at the bank, waiting on surly customers and poisoning Wendy's coffee to relieve stress, until Hell froze over.

It was like polishing a diamond. Once you made the rough cut you couldn't whack off any more big chunks. From then on you accepted the general shape of it and just polished it with finer and finer abrasive until every facet glittered.

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Except tonight. Derek wondered how it would work out. Not that it mattered, of course, but it was kind of interesting in a retro sort of way.

After dinner they went down to the street to walk off the excess food they had eaten. They strolled hand in hand, Gardenia wearing Derek's jacket to protect her from the chilly evening breezes, until they saw a chocolate shop and ducked inside for dessert. It turned out they both liked dark chocolate, and since they were on borrowed time anyway they bought a whole pound of truffles and ate them in the cab on the way back to Derek's apartment.

"Oh man," Gardenia said as she staggered down the stairs, holding her stomach. "I ate waaaay too much."

"Me too. Want some Alka-Seltzer?"

"Alka-Seltzer? You actually have some?"

He shrugged. "No matter how many times I try it, my cooking never seems to improve. I've pretty much given up."

She dropped onto the living room couch. "At least you're prepared for the results. Well, as long as we're going linear tonight, bring on the seltzer."

He went into the kitchen and fixed two glasses, bringing them both into the living room. They sat side-by-side on the couch and sipped at the fizzing water while the quarter-sized tablets dissolved, but before they got to the bottom she started to giggle and he began to laugh with her.

"Nobody would believe us if we told them about this," she said. "I mean, the very idea of letting it go on this long. Without having sex or doing anything really outrageous, either. We should at least leap off the roof into traffic or something."

"That would make it kind of hard to backspace," he pointed out.

"So it would."

"We could rob the bank."

"Done that," she said. "They made me give it all back."

"Yeah, that's the problem." He set his glass down on the coffee table and put an arm around her. "You know what I'd really like to do?" he asked.

"What?"

"Just hold you. You're soft and warm and beautiful and I like being close to you. If you don't mind."

She looked at him in surprise. "Mind? You want to cuddle instead of leap straight into the sack and you think I'd mind? Good grief, where have you been all my life?"

He smiled and drew her into his arms. He felt goosebumps on her skin and said softly, "You're cold."

"No, I'm not."

"Oh."

Her hair smelled like apple blossoms. That's what he had noticed when she first came into his apartment.

"Hey," he said suddenly. "Just before you rang the doorbell I felt a shot of Déjà New. What happened?"

If she was offended by the question, she didn't show it. She laughed softly, leaned back so she could see his eyes, and said, "Nothing, really. I was wearing black and white, too. We looked like a couple of penguins, so I went back home and put on paint instead."

"Ah. I'm sure you looked stunning in black and white, but I can't say I'm sorry you changed." He put his arms around her again, brushing his hands lightly over her iridescent skin.

Some time later, her head resting on the bare triangle of his chest where she had unbuttoned his shirt, she said, "We're not going to undo this, are we?"

"I don't know. What do you think? Can you live with all the night's memories?"

She nodded. "I wouldn't give them up for anything. Except . . . "

"Except what?"

"Now I wish I'd stuck with Three Kings Crown."

"Next time," he said. "Assuming you're willing to risk going out with me twice."

She snuggled in closer to him. "It's a date." ■

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THE BAD SANTA CLAUS

David Phalen

During the post-holiday let-down, the Bad Santa Claus roasts chestnuts in his fireplace, reads over Christmas after-action reports and quality performance reviews, and wishes the press were kinder to him. A label like "the Inept Santa Claus" would have been more accurate, he thinks, since he has never been malicious. A man of his times, the Bad Santa blames the media for most of his public image problems. He let the elves in his legal department talk him out of bringing libel charges against the *Washington Post* (they insisted that negative publicity would make such an action a no-win situation), but visions of someday having his day in court still dance through the Bad Santa's head.

The Bad Santa blames the government as well. The North Pole Expansion and Realignment Act, which broke the Santa Claus monopoly into six "separate and distinct Baby Clauses" was ill-conceived and hastily implemented. The Bad Santa feels his mistakes (FDA-approved candy instead of clean-burning coal in the stockings of children on the "naughty" list, reindeer clatter on rooftops exceeding recommended decibel limits, milk and cookies left unconsumed on fireplace mantels) have been a result of overly restrictive and often contradictory federal regulations, as well as unrealistic timetables for the transference of Santa Claus duties and responsibilities. In the days before the breakup, a Claus was free to be a Claus, without the need for a warren of elves fluent with government contracting laws and regulations.

Finally, the Bad Santa places a small portion of blame for his alleged shortcomings on the Old Santa Claus. According to Santa Claus Regulation (SCR) 12-22 (Santa Phase-In), "Saint Nick" was responsible for "training up to standard all new Clauses," but the Old Santa met with the Bad Santa only once. He offered no practical advice, insisting he left the minutiae of his operation to his elves. "That's what little people are for," he said, his belly shaking like a bowl full of jelly as he poured himself another glass of expensive French wine.

Later, waiting for the hotel elevator, the Old Santa sized up the Bad Santa with eyes only partially softened by his

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registered trademark twinkle.

"Forget the suit and the sleigh," said the Old Santa. "Just think about three billion separate people as selfishly as you think about yourself." The Old Santa nodded enigmatically, laid a finger aside his nose, and took the elevator up to his penthouse suite.

Attempts to live up to these parting words have led to many of the Bad Santa's problems. He spares lumps of coal because he believes children are never really naughty, despite the broad definitions set forth in SCR 12-23 (Child Gift Entitlement Evaluation). His eagerness to complete deliveries before the sun rose led to the numerous "Excessive Clatter" citations and accompanying fines. "Forgotten" milk and cookies stem from doctor's orders to lower his fat intake, consistent with mandates from his workers' compensation carrier.

In spite of the numerous parental complaints filed with the Santa Claus Commission (SCC), threatening suit on the statutorily established grounds of "Loss of a Merry Christmas" (outlined in the Freedom From Improper, Inappropriate, or Offensive Gift Act), the Bad Santa cannot convince himself that he is really doing anything wrong. Forgotten in the furor over football uniforms given to girls and Easy-Bake Ovens left under trees in houses where only boys live, is the fact that the Bad Santa has never given a gift that was not *asked* for. Far beyond the Equal Access to Appropriate Gift Act-mandated psychological profiles, the Bad Santa understands what is going through the head of someone like the quadriplegic child who wishes for a regular bicycle. He gives gifts from the heart rather than from any risk/benefit analysis produced in accordance with SCR 12-24 (Gift Allocation Tables) and other pertinent federal gift-giving regulations.

More and more, the Bad Santa wonders if the position is worth it. Government subsidy checks barely cover expenses, and fiscal regulations curtailing the acceptance and use of non-governmental funds make it hard to stay ahead of the game. Every year, required coverage amounts and attendant premiums for product liability insurance rise. The FAA's increasingly stringent regulations requiring mandatory break times for flying reindeer have made scheduling his rounds nearly impossible. His elves are threatening to unionize, despite increased minimum wage rates mandated by the Nutcracker Act. One of the other Santas recently declared he will not seek reappointment when his term expires. That announcement has the Bad Santa reevaluating his own desires.

Rushing to complete final, hectic preparations, the Bad Santa mourns that little room is left for Christmas miracles in an age when e-mail and faxes are more common than handwritten notes blown to the North Pole on a cold December wind (a practice now prohibited under EPA regulations), when the ASPCA has successfully lobbied to replace red-nosed reindeer with omnidirectional radar.

So it is with reduced expectations that the Bad Santa prepares for this coming Christmas. This year he will not look for the big miracles. He will not expect lives to be changed forever by the things he does. He will seek only the little magic he hopes Christmas might still be capable of bringing, the small wonders like the glorious smile he once saw on the face of a deaf girl, as he stood boot-deep in toe-numbing snow, peeking through a window on Christmas morning to watch her open a package containing a portable CD player. That smile was so honest and full of joy that it brightened the room more than a five-hundred-bulb string of Christmas lights.

In smiles like this, the Bad Santa Claus may find the resolve to hold up his end of the Christmas bargain for one more year, now that snow is falling again, choirs are singing carols, and halls have been dutifully decked—in full compliance with SCR 12-25 (Merry Christmas to All). ■

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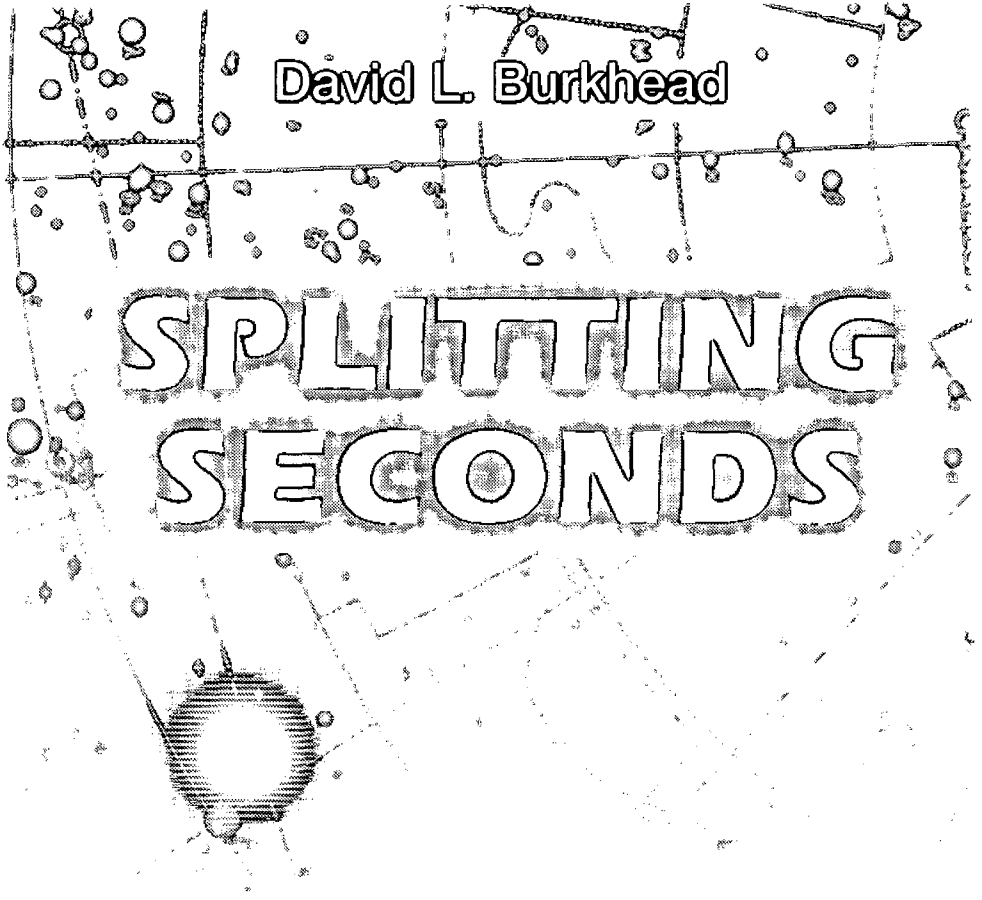
David L. Burkhead

SPLITTING SECONDS



Recognizing a talent is just a beginning. Then you have to figure out what to do with it. . . .

Illustration by Nicholas Jainchigg

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Commander Tanya Everson, MD, stood at the edge of the helipad. The sun was just reaching its zenith, reflecting a brilliant glare from the white concrete. A big Chinook helicopter began to settle onto the pad, its legs reaching downward like the feet of some giant dragonfly. The wind kicked up by its rotors, as they beat the air into submission, tugged at Everson's white uniform and caused her trouser leg to flap annoyingly. The roar of the helicopter's engines and the staccato beat of its rotors drowned out all other sounds.

Everson caught herself gnawing at her lower lip and forced herself to stop—to hide her nervousness. For the first time since anyone had records, there soon might not be a member of her family as a Navy doctor. She had already been passed over for promotion twice, and her third—and last—chance would soon arrive. She had little doubt what the verdict would be. The project she was heading was a dismal failure. It had produced plenty of scientific success—if it were not for security she could have had three or four papers out of it already—but it was producing nothing even remotely useful to the Navy. Her one remaining hope was arriving in the helicopter.

The helicopter's rotors began to slow, and two sailors in dungarees vaulted out of its cargo bay. Another young man followed them, this one wearing crackerjacks, the dress blue uniform of the Navy enlisted man. On seeing him, Everson ducked and trotted forward.

"Seaman Yip?" she asked as she reached the young man.

"Ma'am." The young man snapped to attention, apparently oblivious to the rotors still spinning above them, and saluted.

Everson returned his salute. "At ease, Seaman." She forced herself to stand fully upright. Although there was plenty of room under the helicopter's rotors, she found the temptation to duck while standing under them nearly too great to resist. "If you'll come with me?"

"Yes, ma'am," Yip said.

As they walked toward the gate, Everson looked over her new charge, trying not to appear obvious about it. Yip's uniform was immaculate and perfectly pressed. She would have expected nothing less, of course, since Yip came to her straight from training as a Machinist's Mate. His sleeve bore three stripes, those of a full Seaman, witness to the Navy's program of awarding rank for college credit—a program designed to encourage qualified applicants to enlist. Yip's personnel file, which had been forwarded to Everson before him, said that he had an associate's degree in mechanical engineering technology. While such a degree, and the skills it implied, were important to the Navy as a whole, it mattered little to Everson's project. Physically, Yip was about two inches taller than Everson, five-foot-ten or so. His complexion was slightly darker than hers and his eyes had a hint of an almond shape that implied that one of his parents was of Asian descent.

The marine guard on duty snapped to attention as Everson and Yip approached. Once through the gate, Everson turned to Yip and said, "Welcome to Project Argus, Seaman Yip."

"Thank you, ma'am," Yip said. "Uh, ma'am?"

"Yes?"

"Please forgive my impertinence, but I certainly didn't expect an officer, a commander, to meet me when I arrived."

"No impertinence at all," Everson said. "Argus is kind of a special case." She waved a hand at the scenery around them, the absolutely flat landscape of north-central Kansas. "For one thing, you won't find a ship for five hundred miles."

Yip's eyebrows drew together slightly in a puzzled frown, but he nodded.

"Let's get under cover," Everson said, "and I'll tell you the rest."

"Yes, ma'am."

They walked for about ten minutes. The cool breeze heralded the closing

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days of summer and the approach of fall. Yip kept his head still, but his eyes darted from side to side to look at the various buildings they passed. They arrived at last at a large building surrounded by a double row of ten-foot-high chain link fence. Double V's of barbed wire topped both the fences with a row of insulated posts carrying three strands of electrified wire down the middle of each V. The occasional insect that flew too close to the wire announced its demise with a sharp crack. The tang of ozone in the air further emphasized the high voltage carried in those wires.

A small shack straddled the twin fences, opening into a covered walkway that led into the building. Inside the shack Everson pulled a loop of chain from under her uniform tunic. The chain carried two badges, one in green bearing Everson's picture and the other white with the word "Escort" printed on both faces in large, red letters.

More marines stood guard here, and they too snapped to attention at Everson's approach. Everson slid the badge carrying her picture into a slot on a pedestal next to the gateway, then tapped a rapid series of digits into the keypad atop the pedestal. The pedestal beeped and released her badge and the gate opened. When Yip started to follow her, she held up a hand and the gate slid closed. To one of the guards she said, "I need a visitor's badge for Seaman Yip."

"Yes, ma'am," the marine said. He removed a red badge with the word "visitor" on it in white letters, and a clipboard from his desk. "If you will sign here, please?" He handed the clipboard to Everson who took it and signed. The marine handed the badge to Yip who took it and held it uncertainly.

Everson tapped her left collarbone. "Clip it to your collar and make sure it's visible at all times. You'll have a permanent badge when you've finished in-processing."

Yip nodded and clipped the badge to his collar, adjusting it so it hung clear of his neckerchief. The marine pressed a button at his desk so that the gate beeped as it had for Everson and opened again. Everson beckoned Yip through.

"You keep tight security," Yip observed.

"You could say that," Everson said, "although we're jumping a lot of protocols by bringing you in so soon. We're kind of pressed for time."

"I don't understand," Yip said.

"I'll explain shortly. Here we go." Everson stopped at a door and pressed another pattern of digits on the keypad next to it. The door buzzed and Everson pushed it open. The door opened to an office, her office.

The office held a steel desk in battleship gray. Everson did not spend much time in this office so she had never bothered to request a more decorative one. The bookshelves held her medical references and journals. The only other furnishings in the room were two chairs and a low table. The vents sighed softly as they breathed cool air into the room. "Have a seat," she said, taking her own advice and sitting at the desk.

When Yip had settled into one of the chairs, Everson continued, "We've had you assigned here as part of Project Argus."

"Project Argus, ma'am?"

Everson nodded. "It's something of a gamble. Could you hold on just a moment?"

"Yes, ma'am."

A section in the center of Everson's desk folded up to reveal a computer terminal built into the desktop. Although she had never sought a more decorative desk, she had insisted on a fully functional desk and workstation. With a few keystrokes she called up Yip's record. She nodded at what she saw. The FBI had completed its investigation and Yip had been granted his security clearance. She could make sure that he got a temporary access badge before he left for the day and, in the meantime, she could give him the background.

"First off," she said, "this material is

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classified Top Secret. This material is only to be discussed in an approved secure area. Furthermore, revealing any of this material to anyone not possessing the appropriate clearance and with a need to know is a violation of both Federal law and the Uniform Code of Military Justice."

Yip's expression grew sober. "Yes, ma'am."

"Good," Everson said. "Let me give you some background. Two years ago I was heading a medical research team. We were doing studies on energy use in the brain and correlating them with brainwave activity. We hoped this would provide some better understanding of how the brain worked. The Navy's interest was that understanding of brain function would help in treating head trauma."

Yip looked puzzled.

"The details aren't important," Everson said. "We found that there was an unexplained loss of energy when certain brainwave patterns were active. The brain was generating energy but it was just . . . vanishing." Everson grinned. "It wasn't much, not even enough energy for a good cough. In fact, for a long time we thought it was just instrument error. Still, it was always there when those particular patterns showed up. Over time, we had to accept that it was real. One of the nurses suggested that maybe the lost energy was what powered ESP." Her grin widened.

Yip laughed, only a short bark that he quickly suppressed, then said, "I never believed in that psychic stuff. It's all pure hokum if you ask me."

Everson nodded. "I felt the same way. And I still think you're right. But the kind of psychic stuff you've heard about is not related to what we eventually found. If it were, I'm afraid nobody would have made a big deal about it. Still, we've found just that—telepathy, clairvoyance, some psychokinesis."

Yip's lower jaw fell open. Everson understood what he was feeling. She had been the one to make the discoveries and they had still come as a shock to her.

"Tell me, Seaman," Everson said. "What would having absolutely secure and reliable communications, and totally dependable intelligence, be worth to the Navy?"

Yip sat silently for several seconds before answering. "I don't know. A lot, I guess."

"A lot." Everson sighed. "It's a pity we can't provide it."

Yip looked puzzled again. "I'm sorry. I don't. . . ."

"Sure, we have telepathy," Everson said, "but the range is usually measured in inches. Our best subjects can get out to a couple of feet. Record is five feet. Clairvoyance is even worse. Maximum distance is about two centimeters. We thought we had something with psychokinesis, even the feeble forces generated might have some subtle uses if you could do it through something. Unfortunately, the ranges are as bad as the other two. And the force generated falls as the cube of the distance."

Yip opened his mouth to say something, then shut it.

Everson smiled. "Yes, I said cube. Twice as far, it's one eighth as strong." She shrugged. "We have demonstrated all of these, and we can prove them under rigorously controlled conditions. None of these abilities are useful, however, not as far as the Navy is concerned. We're up for a budget review soon and we probably won't pass unless we come up with something quick. That's where you come in."

"Ma'am?" Yip looked still more puzzled. "I fix plumbing. Psychic powers are a little out of my line."

"Are they?"

"Ma'am?"

"Do you remember the examinations and tests you went through in training? An electroencephalograph was one of the tests. Remember?"

Yip's mouth fell open again as his eyes grew wide and he sucked in a

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quick breath. "Wait a minute. You can't mean. . . ."

"A large portion of our budget went into arranging those tests. You show the requisite patterns, more steadily and more strongly than anyone we've had here yet."

Two days later, Yip had finished in-processing. Everson met him again at the entrance to the security building. This time Yip had his own badge and his own entrance code. He wore dungarees, the light blue Navy work uniform rather than the crackerjacks.

"You settling in well?" Everson asked after returning Yip's salute.

"Yes ma'am," Yip said. "Just wish there were more to do on this base. Even the video games are antiques."

Everson beckoned Yip to follow her as she entered the building. "You like video games, do you?"

"Some," Yip admitted.

"I've never understood the attraction myself," Everson said as she turned a corner in the hallway.

Yip shrugged. "I don't really know. I guess I just find it a challenge to try to anticipate the computer's patterns. The computers in those things get better all the time, harder to second guess, so there's a real sense of accomplishment when you succeed. At least, that's what it does for me."

Yip's explanation did nothing for Everson. She still thought those games a waste of time. "I see," she said. "By the way, I hope tight places don't make you uncomfortable."

Yip looked puzzled. "Tight places?"

Everson grinned more widely. "You'll see. Follow me." Another turn led the way deeper into the building. "The first step is to find out just where your talent lies."

"How do you know I have a talent?" Yip said. "I've never been psychic before, never even believed in that stuff."

"Neither did I," Everson said, "but there they are. Still, it's a good bet that you do have one talent or another. Everyone who's shown the same EEG characteristics you have has had one talent or another. Some have been able to learn other talents in addition to whatever their native ability is. That will be the second, no, the third thing, we check—whether you can learn other talents. Second thing will be trying to push back the limits of your native talent. We still need that breakthrough to turn this into something useful. First thing, of course, will be to determine just what your base ability is."

Yip grinned this time. "Looks like you have my life planned out for me."

"No, just your work," Everson said. "Nice thing about shore duty—once you get off duty, you're very nearly a civilian. She laid her hand on a door. "Here we are." The door swung aside at her push.

The door opened into a small antechamber. Inside a marine stood guard. He saluted. "Welcome back, Commander."

Everson returned the salute. "Thank you. This is Seaman Yip. He'll be part of the project now."

"Yes, ma'am." He pressed a button, sounding a loud buzz. Everson pushed on through the next door, holding it for Yip. She watched sideways, out of the corner of her eye, as Yip got his first glimpse of the main lab.

The lighting in the room was dim, the sounds subdued. About a dozen people worked in various parts of the room, speaking in low voices or even whispers. Poles stood at intervals about the room bearing amber lights. Cove lighting around the edges of the room reflected off the ceiling and gave the room an even, albeit dim, glow.

A large metal object dominated the room. From the outside it looked like two giant aluminum pears stuck together by their large ends. The small ends sat near the floor, one of which faced them and ended in a small hatch, barely large enough for a large sailor to squeeze through. Near the joint of the two pear-like halves two large pipes pierced the

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skin of the object. Frost covered the pipes and whispy trails of cloudy smoke draped over them to spread out on the floor below.

The amber lights turned green and the cove lighting brightened. The people working in the room raised their voices to more normal conversational tones.

A Petty Officer approached Everson and Yip. His name tag read Morgenstern. "Morning, Commander."

"Good Morning, Tom. This is Seaman Yip, latest find from the talent search."

"Welcome aboard," Morgenstern said. He stuck out a hand which Yip took hesitantly. "I'll be your opposite number in this morning's test."

"My what?"

Everson said, "We'll be looking for telepathy first. Tom here is our best telepath, half of the pair that set our record of one-point-three meters."

Yip shuffled half a step backward.

Morgenstern laughed. "It's just communication," he said, his voice radiating cheery friendliness. "I have to be trying to send, and my partner has to be trying to receive, or vice versa, for anything to happen. Works real good so long as we're in range and both have the ability, otherwise nothing. We can't read minds. We can't tell what you're thinking. And we can't find out that you made a new girlfriend last night."

Yip jerked slightly. "How did you . . ." He stepped back again.

Everson sighed. "Quit playing with him, Tom."

Morgenstern grinned. To Yip, he said, "Think about it. It's a small base and rumors travel fast. After all, scuttlebutt is the only form of communication known to travel faster than light. I knew you were coming in today, so I kept my ears open."

Yip seemed to relax a bit, but still seemed wary.

"Tanya's a nice girl," Morgenstern continued. "Treat her right, you hear?"

"If we could get started," Everson said. "Tom?"

"Right." Morgenstern walked toward the far end of the giant, aluminum, double pear.

"Here's your spot," Everson said, gesturing toward the hatch in the near end of the pear.

Yip looked at it uncertainly while, at the other side, Morgenstern ducked down and appeared to wriggle into another hatch in the far end. "What is that thing?"

"We call it the cave," Everson said. "We built it when we were testing to see if any of the talents relied on electromagnetic energy. It's a large dewar flask, like a giant thermos bottle. A vacuum between the walls insulates a layer of superconducting material. That superconductor completely shields the interior from any stray electrical or magnetic fields. The layer also extends between the two halves so no electromagnetic fields can go between the sender and receiver."

Yip said nothing so Everson continued, "The main thing we use it for is to screen out any stray influences that might swamp the rather delicate effects we're trying to measure."

Yip nodded slowly. "What do you want me to do?"

Everson beckoned toward the hatch. "Inside, you'll find a set of disks with differently shaped patterns on them. There'll be a board where you can put those disks; they'll press fit. Simply put them in whatever order you think they should take."

"That's it?"

"That's it," Everson said. "The chair inside will have your head only a few centimeters from Tom's. If you have even the faintest trace of talent then, even untrained, your pattern will match Tom's by half or better. The odds of that happening by chance are so low as to make this a pretty unambiguous test."

"Okay," Yip said. "When do we start?"

Everson gave him a gentle shove toward the hatch opening.

* * *

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Everson knocked once on the door in front of her, evoking an answer from within. "Come in."

She twisted the doorknob and pushed on the door which opened into an office. To the left and right, wooden bookcases ran from floor to ceiling brimming with tomes on subjects as varied as the care and feeding of Siamese Fighting Fish and fleet battle tactics. Pictures covered the far walls of the room, pictures of the room's occupant's family interspersed with pictures of ships aboard which he had served. In front of the picture-covered wall stood a large, mahogany desk. Behind the desk sat Admiral Walter Padretti.

If the Navy recruited middle-aged men, Padretti would have been the perfect model for the recruiting posters. He was an even six feet tall when standing, and still lean despite the hair starting to gray at his temples. Somehow, his bifocals made him look more wise then old. Even his aftershave, as a draft from the room's ventilation brought a whiff to Everson's nose, suggested something of the sea and high adventure. Everson thought it almost a crime to have him saddled with the job of administering an out of the way base, one hundreds of miles from the nearest salt air and true horizon. She marched to his desk, stopped just in front of it, and waited.

Padretti looked up. "Yes?"

Everson saluted. "Commander Tanya Everson reports as ordered, sir."

Padretti returned the salute. "At ease, Commander." He signed a form on his desk, placed it in a folder, and set it aside. "Have a seat."

Everson sat in one of the two overstuffed leather chairs that faced the desk and resumed waiting.

After a moment, Padretti said, "How's that new subject of yours, Seaman Yip, doing?"

"Not as well as I'd hoped," Everson said.

"Oh?"

Everson sighed and shook her head. "Truth is, he hasn't done anything at all. With two weeks of conducting every test I could think of he's still shown nothing: not telepathy, not PK, not clairvoyance, nothing."

"Maybe he lost whatever he had, or maybe he never had anything in the first place."

"That's possible," Everson said. "But if that's the case, then we've been chasing shadows all along. Yip shows, and continues to show, the same characteristics in his EEG's that all the others with the talents have, and nobody who doesn't have the talents has. If these characteristics aren't linked to talents then it's an incredible coincidence that they match up like that. And if they are linked to talents then there must be something I'm missing yet."

"I see," Padretti said.

"Is that what you called me in for?" Everson asked.

"Partly," Padretti said, "but I also have some bad news for you."

Everson sighed. She could guess. "We're having our budget cut again?"

Padretti nodded. "You're having your budget cut again. This time all the way. The board decided to pull the plug on Argus."

Everson sighed again. "Well, I can't say it's a surprise. How long have we got?"

"Finish the current year," Padretti said, "then another three months to close up shop and get everyone reassigned." He drew in deep breath, then continued, "but there's more, I'm afraid."

"More?"

"I've also spoken to Admiral Sembene. He's on the promotions board and let me have a look at the preliminary make sheet." He shook his head. "Doesn't look like you made it this year."

Everson chilled. This was the third time. If she was passed over for promotion again what she had feared most would happen. She would have to resign her commission.

Padretti continued. "There's nothing of-

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ficial about this. They might change their minds before the official list comes out."

"Do you really think so, sir?"

"I'm sorry, Commander, but no. This project wasn't popular to begin with. You gambled your career on its success and, with the scuttlecock being opened it looks like you've lost the gamble. Damn shame too because you're a good doctor, and a good officer, but my opinion only counts for so much."

"I see, sir," Everson said. "I know you tried. Is there anything else?"

"No. That's all."

"Thank you for telling me, sir." She stood and saluted.

Padretti waved her back into her seat. "Hold on a moment. Let's talk." When she had returned to her seat, he continued. "This might actually be for the best, your losing your commission at the same time as the project gets cut off. Since the project is officially a failure, I might be able to get it declassified. Also, I have some friends on the outside. We might be able to get you private funding to continue the research. I've read your reports. What you're getting is definitely real and I think you're right that there has to be a use for it somewhere."

"No, sir," Everson said, "I'd rather you didn't."

Padretti's eyebrows rose. "Really, Commander? Why not?"

"If the project remained in the Navy, how would it be used—assuming we could build range to useful levels?"

"I don't know," Padretti said.

"Well, how would you use it, sir, if you had some folk who could do the things my folk can do over a range of ten to twenty miles?"

"Mm," Padretti thought for a moment. "Secure ship to shore and ship-to-ship communications. Maybe tactical intelligence—see what the opposing commander is going to do so I can counter it."

"Exactly, sir. That's what I thought." Everson grimaced. "Now imagine that I continue the research as a private citizen. No longer is it a Navy project with the Navy having control of it. Instead, it's fair game for anyone else. What happens then?"

"You tell me, Commander. What happens then?"

"I can't be sure, of course, but I suspect the State Department would find uses for it, and what about the CIA?"

A deep scowl furrowed Padretti's face, as if he tasted something foul. "Yes, I see what you mean."

Everson nodded. "Combat, even Naval combat, is a dirty business, but it's downright clean compared to some of the stuff the spooks have to do. I'd much rather the project stayed with the Navy, or even the Army or Air Force, then have it go over to them. I'd rather see it die then see it used by the CIA."

Padretti sighed and nodded. "Very well then, Commander, if that's what you want." He stood and held out a hand. "Look, if there's anything I can do, just let me know. Of if you just want to go down to the club and have a drink. . . ."

Everson did not question his attitude, his acting almost as if someone close to her had died, as she stood and took his hand. Something close to her had died, or was dying—her career. "Thank you, sir," she said, taking his proffered hand. "I'll remember that."

Everson sat at a table in the com club that night. The base was too small to have separate officer and enlisted clubs and this one facility served both. She slowly stirred her drink with a straw before wrapping her lips around the straw's tip and drawing in a mouthful of rum and Coke. She was not drunk, not quite, but was seriously considering becoming so. Her project was over. Her career was over. Sure, as a medical doctor she could find plenty of work in civilian life, perhaps even research, but she *liked* the Navy. Then there was the family tradition. There had always been an Everson serving as a doctor in the US Navy, always. She had had every inten-

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tion of upholding that tradition and continuing in the Navy until forced into retirement. That time had come much sooner than she had ever expected. Five years. Just five years.

She drew in another mouthful of her drink.

The lounge was only about half full, this being only Wednesday. A group clustered around one of the machines, at the far end along a row of video games standing on the side of the room. Someone was playing well enough to attract considerable attention. Everson snorted and took another drink. She had never seen the attraction of video games herself.

While she watched, the crowd parted for a moment and Everson could see the young man at the game's controls. It was John Yip. His face, seen in near profile, was a mask of intense concentration, while his unblinking gaze never left the screen.

Curious, Everson picked up her drink and walked toward Yip and the video machine. Two people had moved, filling the gap in the crowd, but Everson twisted her shoulders and slipped between them so that she was standing just behind and to the right of Yip.

Everson did not know enough about the game to know whether the score Yip had accumulated was impressive or not, but judging by the reactions of the others in the crowd she supposed it was. As she watched, Yip moved the little ship icon to the left, fired, and moved back to the right. The ship's shot raced up the screen and tagged an incoming enemy just as it appeared.

Seeing that, Everson blinked and looked again. Yip seemed to be anticipating the game. She continued to watch as Yip fired three more times . . . before enemy ships appeared on the screen. He never missed; every one of his shots struck a ship that did not appear until after he fired. Either he was anticipating the game in some way or he was controlling it.

Lost in thought, Everson backed through the crowd and returned to her table, her drink all but forgotten in her hand.

"Now," Everson said, sitting in Padretti's office again, "watch." Two weeks had passed since her last visit. This time she brought with her a videotape she had made.

The video showed Yip playing the same video game. The machine was set up in one of Everson's labs, surrounded by a wire mesh screen. A larger cage of wire mesh surrounded both Yip and the machine.

"This is the first sequence of tests," Everson said. "I first wanted to make certain that Yip was actually anticipating the game's actions. We did this by carefully recording all the activity and studying the tapes later at reduced speed."

"Why the chickenwire?" Padretti asked.

"I wanted to screen out any electromagnetic interference. From some of the other subjects, we've learned that electromagnetic fields can interfere with the operation of talents unless the subject has learned to compensate. One of the base engineers told me that a wire mesh would shield out most. It's not as effective as the superconducting plating in the cave, but better than nothing . . . and the best we had on hand."

"I see," Padretti said. "This is interesting, but I don't see how it helps. I can just see myself going to the budget review board and telling them you need more funds so one of your subjects can play video games."

"I understand that, sir," Everson said. "Watch this next part, though."

The scene changed. The wire netting was gone and Yip was playing a different sort of game. The images seemed to somehow hang in front of the screen before Yip and he was firing some sort of weapon that destroyed targets in a three-dimensional playing field.

Padretti hit the pause button. "What is

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that? That's not any game I've ever seen before."

"No," Everson said with a grin. "One of the nice things about this project is that it brought in all sorts of folks. One of my subjects plays with computers. He came up with that. It's a liquid crystal display, like you find on portable computers, with a laboratory laser shined on it. The computer generates a holographic pattern on the screen and the laser builds a three-dimensional image. The program is a simulation—Yip played the role of a gunner defending a warship against incoming attack: missiles, bombs, aircraft, all sorts of things. Once he got the hang of it, he was as good in three dimensions as in two. And he could pick enemy targets out of a mix of enemy and friendly units with no losses to 'friendly fire.'"

"Maybe he's anticipating patterns. People have done that before."

Everson shook her head. "We checked that. Remember the kinds of equipment we have available for the ESP research? We have some true random-number generators, not just the long period repeating sequences that pass for randomness in most computers. The simulations used those so there were no patterns to anticipate. Everything indicates Yip is able to see things about a quarter second before they happen. If he can respond in that amount of time, he can change it. If he sees a miss, he changes aim until he's got a hit."

Padretti chewed on his lower lip for a moment. "That's a remarkable claim. You're sure?"

"Quite sure," Everson said. "I was sure even before we did that three-D simulation. By then I was looking for an application and I think we found one."

"I don't know," Padretti said. "You've done good work and I don't doubt that Seaman Yip can do what you say, but if I go in to the budget committee with this story it will sound like a fairy tale. It does sound like a fairy tale. I don't think I ever even really convinced them that your earlier results were real."

"I know that, sir. That's why I want to do a real world test, not just computer simulations. But we'll need some more equipment for that."

Padretti's eyebrows rose. "Your budget's already being cut off and you want more equipment?"

Everson held up a hand. "It's not much, nothing expensive. I need a tripod mount machine gun for a couple of weeks and some signal rockets to use as targets." She had to grin—as a doctor she had never imagined that she would be requesting ordnance from her superior. "I don't have the authority to requisition that kind of materiel. You do."

"I see." Padretti thought for a moment. "All right. I think Chief Anderson can work a trade for that much."

"Thank you, sir."

"Is that all then?"

"Yes, sir."

After Padretti nodded dismissal, Everson stood, saluted, and strode from the room. For the first time in weeks, she felt hopeful about her project's outcome. And maybe, just maybe a successful project could save her career. After all, once before the Navy had granted an exception to its up or out policy on behalf of an officer working on an important project.

"It's really rather simple," Everson told Yip. She pointed down the firing range toward four wooden posts, planted in a square fifty feet on a side, with yellow bunting streaming between them. "That's the target, where the rockets will be aimed. Your job is simply to prevent any from hitting it." She patted the Browning fifty caliber machine gun. She had never seen one before outside of old war movies. She had not known the Navy still had any and she wondered where Padretti had dredged up the antique. Still, old or not, it was what Padretti had come up with and it would have to do.

"But I've never done anything like this!" Yip said.

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"Just think of it as a different kind of video game," Everson said. "I'm hoping that your ability to anticipate, to see things an instant before they happen, will work here too."

Yip shrugged and pulled on the earmuffs that would protect his hearing from the machine gun's roar. Everson picked up a field telephone and said, "Let 'em go." She donned her own earmuffs.

Even through the earmuffs, Yip's first burst from the machine gun slapped at Everson's ears with near deafening volume. In the distance, one of the signal rockets, pressed into service as makeshift artillery, sailed past, untouched, to fall short of the target area.

Yip hit the next rocket, then two more arrived. Yip hit one, but missed the other which flew on to land in the target square. As the pace picked up, Yip practically glued down the trigger on the machine gun and hosed the sky.

When the launchers, hidden to one side, had finished their barrage, Yip had only succeeded in knocking down six of the eighteen rockets. Four of those that passed him had landed in the target zone.

Everson removed her earmuffs and sighed. "Any idea what happened?" she asked Yip, who had also removed his own earmuffs.

"I . . . think so," Yip said hesitantly. "I could 'see' the miss, but I couldn't get the gun around in time to change it. If I tried to get the rockets further out, where I still had time to get the hit, it was too far to see whether they would hit the target so I had to try to get all of them, but I just couldn't get the gun around fast enough."

"Okay, John," Everson said. "You tried. I'll have to see if I can come up with something else before we get cut off."

"Yes, ma'am," Yip said. "I'm sorry, ma'am."

"You did fine. There's nothing to be sorry about."

"So that's it," Everson told Padretti. "Yip was the best prospect we've ever had for a talent with actual applications and it just didn't pan out."

"Still," Padretti said, "he's certainly impressive. I've never seen shooting like that. Well, it's nothing any computer-controlled, radar-guided system couldn't do and then some, but with that old gun and nothing more than eyeballs for guidance . . ." Padretti shook his head. "That he hit any of those rockets is a wonder."

Everson nodded. "He's a good kid, awfully eager to please, and that somehow seems to be reflected in his talent. But, like all the other talents we've found, it's just not strong enough to be of practical use. He can just foresee a split second into the future. That's not enough to get him ahead of modern computer-guided weaponry." She laughed. "I found a new weapon and it's been obsolete for thirty years."

Padretti rubbed his lower lip. "I'm not so sure."

"Sir?"

Padretti sat silently for a long moment, drumming his fingers against his lower lip. "I think I may have an idea," he said. "There's another project. . . . Well, you wouldn't know anything about it, but if I call in a few favors, pull some strings. If Yip is right about what the problem is, we may just be able to work around it. Are you willing?"

"Of course, sir!" Everson said in surprise.

Padretti shook his head. "There's no 'of course' about it. If this works, it may get Project Argus restored, but I don't think it will get you on that promotion list. It's probably too late for that. You'll probably still have to resign your commission."

Everson swallowed. "I understand that, sir. I'll still do what I can while I'm still here."

Padretti smiled. "That's what I thought you'd say. Let me see what I can do. We'll need a loan of some new equipment, and I'll have to work pretty hard if I'm going to get it here before the budget committee comes in for its final inspec-

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tion." His eyes seemed to unfocus slightly as he waved Everson toward the door.

"Commander?"

Everson looked back at the call coming from the guard shack. The guard waved to her. "There's a call for you."

Everson waved in response and trotted to the shack. Behind her, at the edge of the firing range, a detail of electricians mates were running cables between three trucks: one mounting a device that most resembled a giant rotisserie grill, topped with a doubly gimbaled mirror; another held a gas turbine-powered generator; and the third was home to a control console that seemed to be the ultimate video game, with joysticks and switches to delight any game addict.

The three trucks, and their crews, had shown up that morning with orders showing that they were supposed to be there and at her discretion but Everson had not yet learned what she was supposed to do with them.

At the door to the shack, the Marine on watch handed her the phone.

"Everson," she said.

"Commander," she heard Morgenstern say, "the team from the budget committee is here."

Everson's eyebrows rose. "But they're not due for two more days."

"Yes, ma'am," Morgenstern said, "but they're here now."

Everson rubbed her eyes for a moment and sighed. "All right. It won't be the first surprise inspection we've had."

"Yes, ma'am. Oh, Admiral Padretti is with them and I overheard him say that you would have something to show them."

That brought a frown to Everson's face, then she glanced back at the three trucks and their swarming crews. "Maybe," she said. "Look, find Lieutenant Crandal. Have him give the committee a tour, slow walk, before bringing them out to the firing range. While he's doing that, you get Seaman Yip out here ASAP. I'm not sure what this junk is, but if the Admiral's behind it, then it might be the ace up our sleeve. We might have something for the bean counters after all. Understand?"

"Yes, ma'am. Have Lieutenant Crandall take the committee by the scenic route and shoot Yip to you by express. Can do."

"Great. You're a lifesaver."

"Thank you, ma'am. Is that all?"

"Yes, that's all." She handed the phone back to the Marine and turned back to the field. One of the detail, sporting Chief Petty Officer chevrons, approached her.

"Commander Everson?" His name tag said "Davis."

Everson returned his salute. "Yes."

He held out a clipboard and pen. "Will you sign here, please?"

Everson took the items but did not immediately sign. "What am I signing for?" She started to read the form.

"This is the Mark Thirty-Four, Rapid-Fire, Pulsed Chemical laser," Davis said, waving back toward the trucks. That confirmed what Everson read on the form. "It's new, experimental, and we need a paper trail of all its movements." He grinned and Everson had a mental image of those trucks dropping papers behind them, like Hansel and Grettel leaving a trail of bread crumbs to find their way home.

She signed the form and handed it back to Davis. "Rapid-Fire what?" she asked and followed him back toward the truck.

"Pulsed Chemical Laser," Davis said. "Well, that's the official designation, but we just call it the 'gat laser."

"Gat Laser?" Everson was beginning to wonder if Davis spoke a different language, one that just slightly resembled English.

"Short for 'Gatling.' Here, I'll show you." He hopped up onto the bed of the truck containing the giant rotisserie and held a hand down to her.

Everson took the hand and, with his

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assistance, lightly vaulted onto the truck.

"It's a chemical laser," Davis said. "When some chemicals, in our case hydrogen and fluorine, react, they can be made to produce laser light. It's not the most efficient laser around, but it's compact and packs a real punch." He stooped and opened an access panel on the device's side. "One of the big problems is that your laser material is used up when you shoot. You need to get new chemicals into the laser quickly, then trigger it for the next shot. But if you flow gas through the laser, a lot of unused material goes out with the spent stuff and . . . well, there's a whole lot of other problems." He stood up, holding a cylinder about half a meter long and ten centimeters in diameter in his hands. He handed the object to Everson.

"That's the key to the whole system," he said as Everson took the object and examined it. One end was smooth metal while the other held a thick plug of glass or plastic. Twin rings of burnished copper encircled its ends over thin bushings of some kind of plastic. "It holds, compressed, a metered charge of hydrogen and fluorine."

Everson just shook her head, more convinced than ever that Davis spoke a different language from hers.

Davis slapped the back of the giant rotisserie, the gun. "The breach mechanism loads one of those into a revolving chamber. The barrels then rotate, bringing it into alignment, then—" He tapped the two copper rings. "—an electric discharge gooses it and detonates the hydrogen/fluorine mix. I'm just a glorified electrician, but the research boys tell me that, through the arcane witchcraft of quantum physics, the chemical reaction can be converted into laser light, a whopping powerful burst that can punch through six-inch steel. The gas in the cartridge gets really hot during all this and the pressure goes way up. The heavy metal of the breech keeps everything from exploding and liquid nitrogen cools the cartridge down to reduce the pressure so it doesn't crack when the extractor pulls it free. A lot of our research work was finding an alloy that won't crack anyway when it gets chilled so suddenly. Everything's nice and neat and self-contained."

Everson still did not understand what he was saying, but decided it was not terribly important to her anyway. "How's it aimed?"

"That's the best part," Davis said. He pointed to the gimbaled mirror. "You just turn the mirror. The laser doesn't operate in visible light so you can easily split off a visual signal from the optics and send it to a camera. What you see is what you get. Watch the screen, put the crosshairs on the target, press the button, and zap—ten thousand pulses a minute turn your target into Swiss Cheese." He shook his head, a wide grin on his face. "It's just like playing video games."

Everson nodded. That last bit was clear at least. Something that was just like playing video games was exactly what she needed. She handed back the cartridge.

"Commander?" the call came from back in the direction of the guard shack. "Commander?"

From her vantage on the truck bed Everson looked down to see Yip running across the field toward her. She crouched down and dropped to the ground, followed immediately by Davis.

"Glad you're here," she said when Yip caught up to her.

"Yes, ma'am, although you might not be when you hear." He drew a deep breath, then another, trying to slow his breathing. "Tom said to tell you that Crandall couldn't hold the committee. Well, most of them are going with the Lieutenant, but the head of the committee is on his way here with the admiral. Be here in about fifteen minutes."

Everson groaned, then shook her head and drew in a breath. "Okay, we'll

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have to hurry. Mr. Davis, Seaman Yip here is the person we need to operate your laser. I hope the controls are as easy as you implied."

"Well, aiming and firing is," Davis said. "There are some other things that are a bit more complex, but my crew can handle them."

"Then if you'll take Seaman Yip in hand . . . ?"

"Yes, ma'am," Davis said.

Everson started to gnaw on her lower lip. They only had six or seven of the old signal rockets left to use as targets. Even if everything went perfectly, she did not think they would be enough for an effective demonstration. Well, they would just have to use what they had.

"One more thing, ma'am," Yip said. "Admiral Padretti had a message for you. He said to tell you that a marine artillery company was scheduled to do some live fire drills with battlefield rockets. He arranged for them to do those drills here." Yip waved toward one side of the firing range. "They're out there somewhere and will fire on your order."

Everson could only nod in pleased shock. The admiral had come through for them.

"Welcome," Everson said. The inspection team from the budget committee stood just outside the gate to the firing range. Padretti stood behind them.

"Never mind that, Commander," someone, a civilian, said. His security badge—violet, a color Everson had never seen before—declared his name to be Alcott. "I want to know why you did not come to meet us?"

"I'm sorry, sir," Everson said. "We were not expecting you for several more days and I was in the middle of overseeing a new experiment, one with potentially significant applications." She spread her hands in front of her. "I hadn't even known you were here until just a few minutes ago."

"A new experiment?" Alcott frowned. "I don't understand. Didn't you get the word that your program is being shut down?"

"Yes, sir," Everson said. "Admiral Padretti conveyed that information. However, it seemed to me that we should push as hard as possible to gather as much information as we could while we could."

Alcott nodded, but did not seem at all appeased.

"If you please, sir," Everson said to Padretti, "we are about to begin the new series of experiments. Would you care to observe?"

"I'd like that very much, Commander."

"What's the point?" Alcott said. "The project's over."

"While the project is over as you say," Padretti said, "wouldn't you like to see what your money has been buying?"

"Oh, very well," Alcott said.

"Commander?" Padretti nodded to her.

"If you'll come this way, gentlemen . . ." Everson led the way back to the small collection of trucks. Yip had settled into a seat at the control panel to the laser system. An image of the sky above them glowed on the screen before Yip. Red crosshairs picked out the center of the image. To the left, another, smaller, panel indicated the number of rounds of ammunition remaining. The only control Everson saw was a joystick with a single firing button placed where the operator's index finger would fall.

"What in the world is *that*?" Alcott asked.

Admiral Padretti spoke before Everson could reply, "It's a new system we have on loan from DARPA. They were doing a variety of field tests at various locations so their presence here does not come out of our budget." He smiled and nodded, then turned to Everson. "Commander, why don't you tell us what you've found?"

Everson nodded and dropped a hand to Yip's shoulder. "We've been doing research involving special talents that some people seem to have. Seaman Yip, here, possesses one of those talents,

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one we'd never seen before." Calmly, she explained the research they had done, and what they had found about Yip's abilities.

"You mean to stand there and tell me that you've been spending government money doing research into someone who's good at *video games*?"

"It's more than that, sir," Everson said. "We've found that he can anticipate events, anything he can see or hear, by a fraction of a second. Not only can he anticipate them, but his actions can affect the outcome. Video games, by requiring fast reflexes and having almost instant responses to his reactions, allow that talent to show up. What we're testing today is a possible practical application."

Alcott frowned, then said, "I see. Very well, proceed."

"Admiral?" Everson said.

Padretti nodded and hold out a hand to his aide who handed him a portable radio, the kind most commonly called a "brick." Padretti held the brick to his mouth and pressed the push-to-talk button. "Colonel, if you would be so kind as to commence firing. Could we have a barrage of, say, seven?"

"Seven rounds, yes sir." The tinny voice came from the brick's small speaker.

In the distance, a bright light rose from the horizon, followed swiftly by another. The lights arched over, speeding toward them.

Yip's hand jerked to one side, pushing the joystick along with it and the mirror atop the gun swung in response. His finger convulsed, depressing the trigger. The laser growled, a sound like a nearly continuous peal of thunder. The acid scent of ozone and a frosty draft from the cannon struck Everson. From the corner of her eye, Everson could see frost form on the bin that received the spent ammunition canisters from the laser.

Yip missed and the missile landed squarely in the target zone, adding a new crater to the already pockmarked field.

Before Everson could say or ask anything, another missile rose. Again Yip spun the laser and fired, and again he missed. A third missile. This time Yip hit it, causing the missile to explode and rain debris onto the firing range. He missed the fourth, then swatted the remaining three.

As the debris from the last missile dropped to the ground, Everson turned to Alcott. Before she could say anything, Alcott said, "I fail to see what this is supposed to prove. Any good computer-controlled weapon system could do better than that."

"Commander?" Yip looked up from his seat at her.

"Yes?" she said, giving Yip only half her attention, but grateful for the interruption and the chance to think.

"Could we try it again? I think I've got it now."

"Really," Alcott said, "I do not think we need to have our time wasted by a repeat of that little show."

"Please, sir," Yip looked from Alcott to Everson, "Ma'am . . . really, I've got it now. I can do a lot better."

"Sir?" Everson looked at Alcott, then at Padretti, "Admiral?"

"I don't think another run will harm anything."

"Oh, very well," Alcott shrugged and shoved his hands into his pockets.

Padretti picked up the brick and spoke into it again.

"Colonel, could we have another barrage of seven please?"

"Yes, sir," again the reply came tinny from the speaker.

The first missile arced in only to be met by a burst of laser pulses, as did the second, and five more after it. When the last of the wreckage had come to rest Yip looked back, grinning.

Alcott stared at the field, closed his eyes, shook his head, and stared again. "Could . . . could we see that again?"

"Commander?" Padretti said.

Everson turned to Yip. "Think you can handle it?"

"Yes, *ma'am*!"

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Padretti nodded and again spoke into the brick, "Colonel, could you give us a full barrage? Fire at will, everything you have. Oh, and use full countermeasures. Really wring out our defenses here."

"Yes, sir."

Everson caught a glimpse of Yip's face, reflected in the screen before him. His expression had taken on the blankness she had come to associate with his best performances on the video games he played. Again the gun rumbled as the pulses of laser light lanced out to swat the first missile, then the second. Soon the air was filled with the nearly continuous roar of the gun, the occasional bursts of missile warheads detonating, and the more common crack of solid rocket motors exploding as they were pierced by the laser. Debris fell over the field in an almost continuous rain.

Minutes passed. More missiles flew. More missiles fell. Finally, silence fell over the area. Of more than a hundred missiles fired, Yip had missed only six, all of which had hit well outside the target area. He looked back at Everson again, his grin even wider than before.

Everson met with Alcott and Padretti in Padretti's office.

"Just how many people have this talent of Yip's?" Alcott asked.

"That's very hard to say," Everson said. "He's the first we've ever found, although some of our other talents are showing some signs they can learn to do what Yip does. If I had to guess, just based on how many people we tested to find one person with that talent, I'd say not more than a couple of hundred in the entire Navy."

"Where would you take a research project to develop this particular application of these talents?"

Everson flicked her gaze to Padretti to see him nodding encouragement. "Well, sir, I'd like to look at more complex environments and see how well Yip and others with his talent can pick targets out of a mix of enemy and friendly forces. I'd also like to see how well this anticipation ability can be trained in others who possess the base talent."

"Discriminating in that area is one of the more difficult problems with computer guided weapons," Padretti said. "You generally end up relying on identification transponders which can break down or be jammed, or which the enemy can decipher and use on his own vehicles and weapons."

"All right," Alcott said. "Write up a formal proposal. I know where enough bodies are buried so I'll get it past the budget committee."

"Um, there's just one problem," Padretti said. "Commander Everson was passed over for promotion. I'm afraid she'll have to resign her commission."

"I'm not sure I understand," Alcott said.

"In the Navy, if an officer is passed over three times, that officer has to resign."

Alcott scowled. "I suppose we could find someone else to head the project, but I'd rather not. The commander already knows the procedures and has the rapport with the subjects to make things go smoothly. Plus, she already has the clearances. Bringing in someone else would just cost more." He thought for a moment. "Is this Navy policy firm?"

"There have been exceptions in special circumstances," Padretti said, "but that was a long time ago. I think the only thing that could make an exception now is a presidential order."

Incongruously, Alcott grinned. "Then there's no problem. I know the President and . . . well, let's just say that I think if I asked, he'd be willing to give such an order, particularly once he understood that it would be for the good of the country."

Everson clamped her teeth together to keep her jaw from falling open. She was going to be able to stay in the Navy. Next to Alcott, she could see Padretti looking at her, No grin touched his lips, but the twinkle in his eyes told her that one was there, although hidden. ■

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Allen Steele

HER OWN PRIVATE SITCOM

When a thing gets cheap enough for everybody to have, it's likely to become ubiquitous. But enough is enough. . . .

Illustration by Arthur George

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Ray's Good Food Diner was located on the outskirts of town near the interstate, across a gravel parking lot from a Union 76 truckstop. The town had 1,300 residents, so it supported only two restaurants, the other of which was a pizzeria which served up what was universally acknowledged to be the world's most indigestible pizza. This left Ray's Good Food Diner as the only place within fifteen miles where you could get a decent breakfast twenty-four hours a day.

Every Friday morning at about nine o'clock, Bill drove out to Ray's for the weekly meeting of the Old Farts Club. No one remembered who first started calling it that, but it pretty well described the membership: a half-dozen or so men, each and every one of whom qualified for the senior citizen discount, who liked to get together and chew the fat, both literally and figuratively. There weren't any rules, written or unspoken, against women or children attending the meetings, but since no one had ever brought along any family members—their wives didn't care and their kids were all adults now and, for the most part, living away from home—the issue had never really been raised. Which was just as well; in a world where seemingly everything had been made accessible to all ages and both genders, Ray's Good Food Diner was one of the few places left where a handful of white male chauvinists could safely convene without fear of being picketed.

A grumbling row of sixteen-wheelers idled on the other side of the lot when Bill pulled into Ray's. He parked his ten-year-old Ford pickup in front of the diner and climbed out. The late autumn air was cool and crisp, redolent with the scent of fallen leaves and diesel fumes; he thrust his hands into the pockets of his Elks Club windbreaker as he sauntered past the line of cars. Even without glancing through the windows, he knew which of his friends were here just by recognizing their vehicles: Chet's charcoal-black Cadillac with the NRA sticker in the rear window; Tom's Dodge truck with corn husks in the bed; Garrett's decrepit Volkswagen hatchback with the mismatched driver's-side door and the dented rear bumper. John's Volvo wasn't there—Bill remembered that he was in Daytona Beach, visiting his son's family; and Ned hadn't arrived yet, either because he had overslept or—more likely, Bill thought sourly—he was too hungover from his latest whiskey binge. Poor Ned.

The small diner was filled with its usual clientele: long-haul truckers chowing down after sleeping over in their vehicles, local farmers taking a mid-morning break from their chores, a couple of longhair students from the nearby state university. He smelled bacon and fried potatoes, heard music from the little two-songs-for-a-quarter juke boxes above the window booths: Jimmy Buffett from the one occupied by a husband-and-wife trucker family, something godawful from the one taken over by the college kids. He unzipped his windbreaker, looked around . . .

"Hey, Bill!"

And there they were, sitting around two Formica-top tables pushed together at the far end of the room: the Old Farts Club in all their glory. Chet, Tom, Garrett . . . the regular gang, waving for him to come over and join them. A chair had been left open for him; if there was a better definition of friendship, Bill had never heard of it.

"I suppose you're wondering why I called you all here today . . ." he began.

"Aw, shut up and sit down." This from Chet, seated at the end of the table.

"We begin bombing in five minutes," added Garrett.

The same opening lines, reiterated again and again over the last—seven? ten? fifteen?—years. Friendship is also the condition when your buddies tolerate your lame jokes long after they've ceased to be funny. Or perhaps it was only a prerequisite of growing old.

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Bill took his seat, looked around. Everyone had a mug of coffee before him, but there were no plates on the table. Another unspoken rule of the Old Farts Club was that you ate when you were hungry; no one had to wait for the others to arrive. "Thought I was running late," he observed, "but it looks like we all got here at the same time for once."

"Nope. I've been here for a hour." Chet nodded to Tom. "He's been here almost as long as I have."

"Almost an hour," agreed Tom, studying the menu.

"I got here . . ." Garrett checked his watch. "Exactly forty-two minutes ago." Garrett was like that. "We're still waiting to order."

"You mean, we've beenwaiting for someone to ask if we want to order," Chet said.

"Yes, this is true."

Puzzled, Bill glanced over his shoulder, scanned the room. The diner was no more or less busy than it ever was on a Friday morning; at least a third of the booths were vacant, and only a handful of people sat at the lunch counter. "So where's our waitress?" he asked. "Who's working today?"

Three men who had been nursing lukewarm coffee for the last half-hour or more looked at each other. "Joanne," Chet murmured darkly. "But don't bother to call for her. She's in her own private sitcom."

As if taking a cue from an unseen director, Joanne suddenly appeared, walking backward through the swinging kitchen door, balancing a serving tray above her left shoulder. "Okay, all right!" she yelled as she turned around, loud enough to be heard over the dueling jukeboxes. "Just everyone hold their horses! I'm coming as fast as I can!"

In all the uncounted years he had been coming to Ray's, all the many times Bill had observed Joanne at work, he had never before seen her shout at her customers. Joanne was born and raised in this town, and started working at Ray's when she graduated from the county high school. The years had been rough on her—a low-paying job, a drunk husband who abandoned her after two years, a teenage son who dropped out of high school and was now seldom home—and long ago she had lost the looks and charm that had made her a one-time prom queen, but she was still, for guys like himself and the rest of the Old Farts, the little girl they had all watched grow up. If there were good ol' boys, then she was a good ol' gal.

Her uncustomary brashness drew his attention; the object hovering above her held it. A miniature helicopter purred about a foot above her head, its spinning rotors forming a translucent halo; as she walked past the lunch counter, it followed her into the dining room. Suspended beneath the rotors was a softball-size spheroid; a tiny, multijointed prong containing a binaural microphone protruded above three camera lenses that swiftly gimbaled back and forth.

"Oh, lordie," he murmured. "Joanne's got herself a flycam."

"Is that what it's called?" Like everyone else at the table, Tom was watching Joanne. "I knew they were called something, but I didn't know what it was."

"I call it a pain in the you-know-what." Garrett picked up his cold coffee, took a sip, made a face. "What she's doing with one here, I have no idea."

Joanne sashayed to a pair of truck drivers sitting in a nearby booth, the flycam keeping pace with her from above. "All right," she announced as she picked the plates off the tray and placed them on the table, "a western omelette with a side order of bacon, two scrambled eggs with sausage, a glass of orange juice and a glass of tomato juice. Will that be all?"

The drivers looked at the plates she had put before them. "Ma'am, I ordered a ham and bacon omelette," one said quietly, "and I think my friend here asked for his eggs over-easy with ham."

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"And I didn't ask for tomato juice, either," added the other. "I wanted orange juice, too."

"We-e-e-elll!" Joanne struck a pose, one hand on an out-thrust hip, the serving tray tucked under her other arm. "I suppose one of us made a mistake, didn't we?"

"Yes, ma'am, I suppose one of us sure did."

Joanne looked over her shoulder. "Ray!" she bellowed in the direction of the kitchen. "You made a mistake!" Then she pivoted on her heel, and raised her arms. "I swear," she loudly proclaimed to no one in particular (except, perhaps, the flycam), "it ain't my fault no one 'round here speaks English!"

Then she flounced away, her hips swinging with overdone suggestivity. The two drivers gaped at her. "I'm not paying for this!" one yelled at her. "This isn't what I ordered!"

Joanne ignored them. She was already advancing on the two college kids sitting in the next booth. They stared at the flycam as it moved into position above their table. "What'll you have, guys?"

One of the students pointed at the drone. "Uhh . . . hey, is that thing live?"

"Taped," she said briskly, dropping her voice for the first time. "Just pretend it's not there." She raised her voice again. "So what'll you have, kids?"

He gawked at the camera, absently combing back his hair with his fingers. The other student nervously looked back at his menu. "I . . . uh . . . can I have . . . ?"

"Son, what were you smoking last night?"

Startled, he looked up at her. "What?"

"Oh, you were smoking what." She beamed down at him. "That's new to me. I'm just a poor country girl."

"Huh? What are you . . . ?"

"Look, dudes, let me rap with you, okay?" She lowered her order pad, bent over the table to look them in the eye. The flycam dropped a few inches closer, its cameras recording everything. "I was your age once, and yeah, I used to get pretty wild . . ." She took a deep breath." But dope is just a bad trip, y'-know what I'm saying? A thing is a terrible mind to . . ."

"Huh?"

"Aw, dammit." She shook her head, glanced up at the flycam for a moment, then returned her attention to the students. "I mean, a mind is a terrible thing to waste, and you've got your whole future ahead of you."

"I . . . what?" Stammering with disbelief, the student glanced between Joanne and the hovering drone. "I . . . hey, lady, I don't use drugs!"

"Neither of us do!" His companion peered up at the flycam. "Hey, we're straight! I swear, We're straight! Geez, we just came in here to get breakfast and . . . !"

"Think about it," Joanne said solemnly. "Just . . . think about it."

Then she was off again, heading for another table, the flycam following her like an airborne puppy. "Can we at least get some coffee?" the first student called after her.

"What in the world is that fool girl up to?" Tom murmured.

"Taping another episode of her net show." Chet watched her progress across the dining room. "*Joanne's Place*, something like that . . ."

"But this isn't her place." Tom was bewildered. "It's Ray's. Ray's Diner. What's she doing, some kind of TV show?"

As always, Tom was behind the times. No surprise there; he was still trying to get over Bush losing to Clinton. But Bill recognized the technology; eight years might have gone by since he retired as physics teacher at the local high school, but he still kept subscriptions to popular science magazines.

Flycams were miniature spinoffs of unpiloted military reconnaissance drones. Initially intended to be used for law enforcement, only police departments were able to buy them at first, but it wasn't long before they became inex-

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pensive enough to enter the consumer market, and now they were available at electronics stores for approximately the same price as a high-end camcorder. Early versions were remote-controlled, but later models had the benefit of newer technology. They could be programmed to automatically track someone by his or her body-heat signature and voice pattern and follow them around, during which time they would record everything he or she did and spoke, with the data being transmitted to a nearby datanest. Bill figured that Joanne had probably parked the nest in the kitchen, or perhaps under the lunch counter.

"It's a net show, Tom." Chet watched Joanne perform for another pair of truckers seated at the counter. Now she was playing the coy vixen while she took their orders; she had loosened the top button of her blouse, and she was letting them get an eyeful of pink cleavage as she freshened up their coffee. The drone waited overhead, its mike and lenses catching everything. "She's got that fly-thing following her around while she works, and when she's done at the end of the day, she takes it home and makes it into another episode."

"Like for a TV show, you mean."

"The net." Chet gave him an arch look. "Don't get out much, do you? No one watches TV anymore 'cept old duffers like us."

"Hey, did anyone catch *Miami Vice* last night?" Garrett, always the peacemaker. "They showed the one where Crockett and Tubbs . . ."

"See what I mean?" Chet waggled a finger at Garrett, cutting him off. "We're used to shows about make-believe characters in make-believe stories, but that's not where it's at anymore. Now you can go out, buy one of those things, hook it up to your DVD and your home computer . . ." He snapped his fingers. "You've got your own show."

"My wife really likes that stuff." Garrett had surrendered; no sense in trying to talk about an old cop show in perpetual rerun on a local cable station. "Every night, she sits down in the den and just searches back and forth, looking for the newest shows people have put on."

"On her computer?" Slowly, Tom was beginning to catch on. "You mean, like on . . . whatchamacallit, web sites?"

Bill nodded. "Sort of like that." He didn't add that the web sites were old tech; no sense in confusing him any further. "The net has all these different nodes, millions of them, and you can rent time there, put in your own program. Anything you want."

"Anything?" Tom's eyes widened. "Like . . . you mean . . . anything you've recorded with one of those . . . ?"

"Yes. Anything."

Yes, anything. Bill had his own desktop system, a decrepit old Mac he had been nursing along for years with mother boards and internal modems bought from online junkyards or cannibalized from CPUs purchased at flea markets. Slow as autumn sap from a maple tree, but it was enough to let him patch into the net if he didn't mind waiting a few extra minutes.

He didn't mind, although there wasn't much worth looking at, really. Too much homemade porn, for one thing; every fool with a flycam seemed to think he was king stud of the universe when he got in bed with his wife or girlfriend, and wanted to share his glory with the world. Only slightly less prevalent were the boatloads of fanatics who sincerely believed that they had stumbled upon vast conspiracies involving crashed UFOs, biblical prophecies and political assassinations; their flycam caught them standing outside military bases, government offices, or ancient Egyptian ruins, delivering rants fascinating only for the width and depth of their meaninglessness.

Those shows were easy to ignore, yet there also the ones made by thousands of ordinary people during the course of their daily lives. They modeled their shows after the TV programs of their

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youth—*Cheers*, *Seinfeld*, and *Major Dad* for the sitcom enthusiasts; *ER*, *Melrose Place*, and *Law & Order* for the would-be dramatists—and tried to live up to Hollywood tradition. Convenience store clerks who fancied themselves as comedians. Night watchmen thinking they were action heros. Bored housewives staging their own soaps. Teenagers solving mysteries in shopping malls. Truck stop waitresses producing sitcoms, starring themselves in the lead role.

Joanne disappeared into the kitchen, pausing for only a moment to carefully hold open the door for the flycam. "There she goes," Chet murmured. "Probably going to check the system, maybe insert a fresh disk, put a fresh battery in the 'cam. When she gets home, she'll look at everything she got today, edit it down, maybe add some music and a laugh track. Then she'll put in on the net. *Joanne's Place*, staring Joanne the wisecracking waitress. Just a poor ol' country girl trying to make it through the day."

He picked up his coffee cup, saw that it was empty, put it back in its saucer. "Jesus Christ. And all I wanted was . . ."

The door swung open again and a lean young man in a cook's apron carried out a couple of plates of food. "There's Ray Junior now," Garrett said. "Let's see if we can get him over here." He raised a hand. "Hey! Ray!"

Ray acknowledged him with a nod of his head before he went to the two drivers who had complained about their breakfast. He delivered the reorders and spent a minute apologizing for the foul-up, then scurried around the room, pouring coffee for other disgruntled patrons. Bill couldn't help but to feel sorry for him. Ray Junior had taken over the diner a little over a year ago when his dad retired and moved to Florida; he had done well to keep the family business going, especially on this part of the interstate where nearly every other truck-stop cafe was owned by one restaurant chain or another, but he couldn't afford to lose regular customers.

"Ray, what's going on with Joanne?" Chet asked when Ray finally got to their table. "I've been here nearly a hour now and she hasn't taken our orders."

"I'm really sorry about this." Ray had fetched a cup for Bill and was pouring coffee for everyone. "I'll get her over here as soon as she comes off break."

"She's taking a break?" Chet glanced meaningfully at the others. "At least the second one she's had since I've been here."

"I'll get her back here."

"You ought to fire her. She's more concerned with that damn toy of hers than with doing her job."

"Well . . ." Ray Junior absently wiped a rag across the table. "Y'know, Chet, I really can't do that. Joanne's been here for nearly eighteen years. She's like family. And . . ."

He hesitated. "And?" Garrett prompted.

Ray shrugged. "Well, y'know, we've never been able to afford so much as a billboard. All we've ever had was word-of-mouth. Meanwhile we've got competition from all the chain operations down the highway. But this show she's doing . . . well, she always puts the name of the place in the credits . . ."

"So it's free advertising," Bill finished. "You're hoping it'll draw more customers."

Ray nodded. "The ones that get popular . . . y'know, get a lot of hits . . . and, well, y'know, if it gets picked up by one of the major net servers, AOL or someone like that, then it could make us . . ."

"Famous," Chet said. "Famous across the whole country. Soon you'll be taking down the old sign, put up another one." He raised his hands, spread them open as if picturing a brand-new fiberoptic sign. "I can see it now. 'World-Famous Joanne's Place.' Maybe you can even sell T-shirts and bumper stickers."

"You know I'd never do that," Ray Junior said quietly.

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Chet scowled. "Naw, I'm, sure the notion's never occurred to you."

"Of course you wouldn't," Bill said quickly. "Thanks for the coffee, Ray. Sorry to keep you."

"On the house. Same for breakfast," he added as he moved away from the table. "I'll get her out here to take your orders."

"Hear that?" Tom said as Ray Junior beat a hasty retreat to the kitchen. "Breakfast on the house! Not bad, huh?"

"No," Bill said. "Not bad at all."

There was an uncomfortable silence at the table. "So . . ." Garret said at last. "Anyone seen today's paper?"

That was how the Old Farts usually spent their Friday meetings: discussing what they had read in the paper. Baseball season was over, so now it was time to talk football. Sometimes the subject was politics, and how those damn liberals were destroying the whole country. Or maybe it would be about what was going on in Russia, or the people who were about to go to Mars, or someone famous died last week, and pretty soon it would be close to eleven and it was time for everyone to go home and do whatever it was that country gentlemen do in their golden years. Check the mailbox, feed the dogs and cats, putter around the yard, make plans to have the kids over for Thanksgiving. Take a midafternoon nap and wait for the world to turn upside-down again, and hope that it didn't fall on you when it did.

"'Scuse me." Chet pushed back his chair and stood up. "Need to get something from my car."

"What did you leave?" Tom asked.

"Just some medicine. Don't let no one take my seat." He pulled his denim jacket off the back of his chair and shrugged into it as he walked past the lunch counter and pushed aside the glass door next to the cash register.

Garrett mentioned an awful murder that had occurred a few days ago in the big city a couple of hundred miles away, the one that had made all the newspapers. Pretty soon everyone was talking about it: how it had been committed, who had been arrested, whether they really done the deed, so forth and so on. Bill glanced over his shoulder; out the window, he saw that the trunk lid of Chet's Cadillac had been raised. He watched Chet slam it shut; he turned and began walking back to the diner.

"Funny place to keep medicine," he murmured.

"Huh?" Tom cupped an ear. "What's that you say?"

"Nothing. Never mind."

Chet came back into the diner, took his seat again. The rest of the guys were still discussing the murder, but he didn't seem to have anything to add; he simply picked up a menu and opened it to the breakfast page. Bill noted that he didn't take off his jacket.

A couple of minutes later, the kitchen door banged open again, and there was Joanne. The flycam prowled overhead, filming her every move, as she imperiously studied the dining room. Act II, Scene II: Joanne returns from break. Cue incidental music, audience applause.

"Hey, Joanne!" Garrett raised a hand. "Could we have a little service here, please?"

She heaved an expansive sigh (the audience chuckles expectantly), then pulled pen and order pad from her apron. "Can't a girl get a break 'round here?" she said (the audience laughs a little louder) as she came over, the flycam obediently following her.

For the first time, Bill noticed how much makeup she was wearing: pancake on the cheeks, rouge around the eyes, red lipstick across the mouth. She was trying to erase her last ten years, at least for the benefit of the camera.

"Seems to me that's all you've been taking lately," Chet replied, not looking up from his menu. "We've been waiting over an hour now."

Joanne dropped her mouth open in

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histrionic surprise (*Wooo*, groans the audience) as she placed her hands on her hips. "We-l-l-l-l! I didn't know you were in such a gosh-darn hurry! What's the matter, Chet, you waiting for a social security check?" (More laughter.)

Chet continued to study the menu. "Joanne," he said quietly, "I've been coming here to eat before you were born. I bounced your little fanny on my knee when you were a child, and told Ray Senior that he should give you a job when you got out of school . . ."

"And if it wasn't for you, I could have working for NASA by now!" (Whistles, foot-stomping applause.).

Chet ignored her. "Every time I've come here, I've put a dollar in your tip glass, even when you've done no more than pour me a cup of coffee. So after all these years, I deserve a little common courtesy, don't you think?"

Joanne's face turned scarlet beneath the make-up. This wasn't part of the script. "Well, I don't . . . I don't think I have to . . . I don't have to . . ."

"Joanne," Bill said softly, "just take our orders, please. We're hungry, and we want to eat."

"And turn off that silly thing," Chet added. "I'd like a little privacy, if it's not too much to ask."

Reminded that the camera on her (the audience coughs, moves restlessly) Joanne sought to recover her poise. "We-l-l-l-l, if it's privacy you . . . I mean, if you don't . . . I mean . . . if you don't mind, I'd just as soon . . ."

"Sorry," Chet said, then he reached up and grabbed the flycam.

The drone resisted as his fingers wrapped around its mike boom, its lenses snapping back and forth. Its motor whined as the rotors went to a higher speed, and for a moment it almost seemed alive as it fought against Chet's grasp, then he yanked it down to the table.

Tom's coffee went into his lap and Garrett nearly overturned his chair as they yelled and lurched out of the way. "No! Hey!" Joanne reached for the flycam as Chet turned it over. "Stop! What are you . . . ?"

Chet pushed her aside with one hand, then twisted the drone over on its back. The rotor blades cleaved through a plastic salt shaker and swept the pepper cellar halfway across the room before they snagged against the napkin dispenser.

Bill pulled his coffee mug out of the way. "Chet, what the hell . . . !"

Then Chet pulled out from beneath his jacket the tire iron he had fetched from his car trunk and brought it down on the flycam. The first blow shattered the camera lens and broke the mike boom, and the second shattered its plastic carapace and ruined a compact mass of microchips, solenoids, and actuators. The third and forth blows were unnecessary; the flycam was already an irreparable mess.

Then he dropped the tire iron on the table and sat down. There was a long silence as everyone in the diner stared at him. Then . . .

Long, spontaneous applause from the live studio audience.

As Joanne stared at the wreckage on the table, Chet picked up his menu and opened it again. "Okay," he said, letting out his breath, "I'll take two scrambled eggs, bacon, home fries, wheat toast, and tomato juice. Please."

Tears glimmered in the corners of Joanne's eyes. "I don't . . . I don't believe you just . . . that was my . . ."

"Show's canceled, Joanne." Ray Junior, standing at the lunch counter behind them, spoke quietly. "Will you just take the man's order?"

Joanne's hands shook a little as she raised her pad and dutifully wrote down Chet's order. Then she went around the table and copied down everyone else's. Tom asked for blueberry pancakes, link sausage, rye toast; Garrett requested a western omelette, no fries or toast, and a large glass of milk.

Bill had lost his appetite; he only asked for a refill of his coffee.

Joanne snuffled a bit as she thanked

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no one in particular, then she turned away and marched on stiff legs back into the kitchen. No one said anything when Ray Junior came out a moment later with a brush and a plastic garbage sack. He avoided everyone's gaze as he silently whisked away the debris, then he vanished through the swinging doors.

"Well . . ." Tom began.

"Well," echoed Garrett.

Chet said nothing as he slipped the tire iron beneath his chair and picked up his coffee.

"Joanne's a good kid," Garrett added.

"That she is. That she is."

"Leave her a good tip, guys. She deserves it."

"Yeah, she certainly earns her money."

"Hard-working lady."

"Damn straight. That she is."

More silence. Across the room, someone put a quarter in a jukebox. An old Johnny Cash song entered the diner. The door opened, allowing inside a cool autumn breeze; a heavyset driver sat down at the counter, took off his cap, and picked up the lunch menu. A sixteen-wheeler blew its air horn as it rumbled out of the lot, heading for parts unknown.

"So . . . Braves blew it again, didn't they?"

"Yep. That they did." Bill cleared his throat. "Now it's football season."■

IN TIMES TO COME

Ben Bova, well known for (among many other things) his novel *Mars*, takes us back to the Red Planet with our cover novelette for February. When the first explorers reach Mount Olympus, they're up against one of the most awesome natural challenges in the Solar System. But sometimes, when you're attacking something very big, it's the little things that can get you. . . .

We'll also have a wide range of other fiction, including very different but equally thought-provoking novelettes by **Christopher McKitterick** and **Stephen L. Burns**.

Our science fact articles are usually about new developments rather than "reviews" of things that have been around for awhile. Next month we make a well-deserved exception for "Digital Matter," by **Stephen L. Gillett, Ph.D.** Presumably most *Analog* readers already have some acquaintance with quantum mechanics, but too many discussions of the subject create the erroneous impression that quantum and "normal" phenomena occupy two quite separate realms of the universe. Not so; everything is quantum mechanical, and "everyday" things are just a limiting case. Dr. Gillett's article just may give you your clearest-ever understanding of some of the most basic of principles, and just how the quantum and macroscopic worlds are really one.

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THE REFERENCE LIBRARY Tom Easton

Proxies, Laura J. Mixon, TOR, $24.95, 444 pp. (ISBN: 0-312-85467- 6).
Mir, Alexander Besher, Simon & Schuster, $23, 297 pp. (ISBN: 0-684- 83087-6).
Carnivores of Light and Darkness, Alan Dean Foster, Warner, $23, 344 pp. (ISBN: 0-446-52132-9).
The Ghost of the Revelator, L.E. Modesitt, Jr., TOR, $23.95, 303 pp. (ISBN: 0-312-86426-4).
After the Blue, Russell Like, Brunswick Galaxy Press (P. O. Box 4213, Highland Park, NJ 08904), $12.95, 255 pp.(ISBN: 0- 9661039-0-4).
Dark Tales & Light, Bruce Boston, Dark Regions Press (P. O. Box 6301, Concord, CA 94524), $6.95, 68 pp. (ISBN: 1-888993-15-4).
This Is the Year Zero, Andrew Weiner, Pottersfield Press (Lawrencetown Beach, 83 Leslie Road, East Lawrencetown, Nova Scotia, Canada B2Z 1P8), $16.95, 192 pp. (ISBN: 1-895900-14- X).
The Story of Libraries: From the Invention of Writing to the Computer Age, Fred Lerner, Continuum, $24.95, 264 pp. (ISBN 0-8264-1114-2).
Time: A Traveler's Guide, Clifford A. Pickover, Oxford, $25, 285 + xviii pp. (ISBN: 0-19-512042-6).

Life changes.

In the last few weeks, I have gotten divorced after thirty-one years of marriage, had two cataracts removed (what a difference!), and been raised from adjunct to half-time professor (with fringe benefits!). I feel like I'm starting life all over again.

But some things don't change. I've been here, writing this Reference Library for you, for over twenty years, and though I'll have to retire or drop dead in harness at some point, for the moment I have no intention of quitting. To prove it, here's one more column:

For a thriller with brains, try the complex brew of Laura J. Mixon's **Proxies**. The time is the height of the greenhouse warming, when people who spend much time outdoors must wear protective suits. Waldoes are big business, but they don't look much like humans and there has appeared a tendency for long-term waldo pilots to go a bit buggy. However, a secret research project has devised robotic bodies indistinguishable from human except in their strength and relative indestructibility, powered by antimatter reactors, and controlled by pilots who have been raised from infancy in pods or "creches" with all their experience mediated through their humanoid proxies. And the kids are perfectly sane, as—of course—are those in charge of the research project.

Except: In Chapter 1, Mixon shows us "Mother" Taylor, the head of the Kaleidas unit of the project, in orbit, as a raving lunatic, paranoidically suspicious, fond of punishing her underlings, including the children. She also hints that the oldest of the kids, Pablo, has an internal alter ego named Buddy, and the attentive reader draws the connection with the abuse and thinks of multiple personality disorder.

Chapter 2: A proxy disappears from the Austin branch of the project. Its internal tracking beacon shows it heading toward Carli MacLeod, the woman responsible for the invention of instantaneous communication (which makes proxy technology feasible), daughter of

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a powerful government official, and a potential recruit for Kaleidas. Its pilot, Dane Elisa Cae, thinks she is a woman, but her memories are fragmentary and some of them are male. And when the Kaleidas and Austin folks try to figure out who the pilot is, they can't do it. All pilots are accounted for.

Now we hear from Buddy, who wants to stop the Kaleidas group's secret agenda, and we begin to sense a very interesting story in the making: Multiple personality disorder reified, each alter given its own body, free to work out its own life or to confront the others in the "flesh," not just internally. Yet this is only a thread in Mixon's tale. She has chosen to focus more on the external world, the attempts to protect Carli MacLeod, her objections to being shadowed, her father's involvement in the secret research project, the political machinations that threaten the project's continued existence, the revelation of Kaleidas's true agenda in all its nastiness, and the hope of something better.

Mixon raises serious ethical and moral questions here, from doing research on children to the preemption of resources for unapproved purposes. Her conclusions are not those of conventional society, but in context they are surely appropriate. Unfortunately, she does not lead the reader to them as well as she might. Her tale seems marred to me by arbitrary leaps.

Yet the tale remains very interesting. There are the philosophical threads for those who treasure such things, but there are also murder and chase, kidnapping and piracy, loyalty and betrayal, and high space adventure.

As I said, a thriller with brains, and it could make a great movie. Enjoy.

Alexander Besher's **Mir** is a thriller with grander ambitions (the acknowledgements page thanks Dostoevsky for "blazing the way") but fewer brains. Indeed, its first half kept making me think Besher was trying—and failing—to imitate P. G. Wodehouse rather than any master of Russian literature.

Mir is billed as "a novel of virtual reality," but though its future cyberspace has many recognizable features, its brand of VR takes off in a new direction perhaps best thumbnailed by saying that, for the software natives of Besher's cyberspace, our world is the virtual one. That is, Besher is trying to blur the boundaries. Unfortunately, he is only partly successful.

The tale starts off well enough. Meet Alex Fortuna, who works for the Avatar Immigration and Naturalization Service, trying to keep illegal alien avatars (software representatives of human beings) out of US cyberspace, discovering one of her coworkers under attack by biofractal computer bugs. Register the Fourth Reich, which is rounding up Jewish avatars and putting them in virtual concentration camps. Meet Alyosha, the terrorist who has just had a sentient tattoo applied to his hide. When a meet goes wrong, the tattoo leaps to a tourist, and now the hunt is on.

Sentient tattoos are devices that are supposed to act as avatars, leaping from skin to cyberspace and back at their owner's whim. This one, however, conceals an artificially intelligent virus downloaded from space and modified by the Russian tsar's secret police to control minds. One of those cops is bent, though—in debt to a casino, hard pressed for funds, auctioning the secret of the Mir virus to the highest bidder, which looks to be that Fourth Reich. He wants the tattoo back, but the tourists have fled back to California where Tibetan lamas drive tantric Yellow Cabs and perform karmic artificial resuscitation, among other things.

You get the picture. There are some nice ideas here, but a sentient tattoo is a heck of a thing to swallow. Mixing in the fancies of New Age mysticism as if they had any objective reality makes me choke. Besher seems to toss in any and everything that strikes him as nifty,

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which at times makes his story feel quite arbitrary.

There's no doubt that Besher can write, but he needs to discipline his imagination if he expects to engender any willing suspension of disbelief, at least among *Analog* readers.

Alan Dean Foster has never seemed to hold ambitions to be a Shakespeare or a Dostoevsky. He is the modern epitome of that ancient SF writer who said that he and his fellows were competing for the reader's beer money. He doesn't offer wine, certainly not champagne, but good value, good times, a song and a laugh and even a hoot or two, and memories that can make one smile.

That is, he has produced an immense number of entertaining novels, many of them very successful, and his new series bids fair to continue his record. **Carnivores of Light and Darkness**, the first volume in his *Journeys of the Catechist* trilogy, begins on the shore of a desolate land inhabited by the Naumkib, simple herders of cattle and sheep who live in harmony with their limited resources and are not at all above dining on their neighbors (waste not, want not). One day, the sea delivers a collection of strangely dressed bodies to the shore. As the Naumkib salvage their armor and jewels and chops, Etjole Ehomba discovers that one of the bodies yet lives and listens to his story: In a land far away, the Visioness Themaryl "was carried off by that pustulance that walks like a man and calls itself Hymneth the Possessed." The nobles of her land, Laconda, pursued and perished, and the bodies on the beach were the sole few to make it this far, only to be ambushed and destroyed in turn while Hymneth the Possessed carries his victim off to fabled Ehl-Larimar on the far side of the sea.

And then the stranger passes his mission on to Etjole Ehomba who, being an honorable man, cannot refuse. He says goodbye to his wife and children, accepts the blessings and gifts of the Naumkib elders, and sets off to right a wrong. The journey will be long, the obstacles many, and he will encounter a prophecy of failure and his own death, but he will not turn aside. He will acquire two sidekicks, a treasure-seeking rogue named Simna and a lion-cheetah hybrid named Ahlitah, and every time Simna calls him a mighty wizard and warlock for his ability to tame whirlwinds and slay sand monsters, he will insist that he is but a humble herder of beasts. Sure, he knows how to talk to beasts, and sure his sky-metal sword has powers, and sure, the old women of the Naumkib equipped him well, but he has no real talents of his own. Credit the old women, the smith, the requirements of Naumkib life.

He's just a man, he says. Competent in the mold of the classic Campbellian man-who-can, perhaps, but just a man with a well-stocked bag of tricks. His chief talent indeed seems to be keeping his cool, and this is enough to entertain the reader as Foster devises dilemmas and monsters to set against this hero and promises that Hymneth the Possessed will be something else again.

At the same time, Foster tells us, Etjole *is* exceptional among his people. He's tall, for one thing, and honorable. And at the end of this volume, he turns out to be something quite impressively more than mere human. No details, folks, but this was something that jarred me, that struck me as rather more than a little bit of cheating, even along the lines of "They pushed him off the cliff so he sprouted wings." This one's a great deal of fun, a very pleasant read, worth recommending despite those "wings" at the end. If Foster can keep himself from giving Etjole more than one new ability per volume, the series will remain fun without collapsing under the weight of excessive improvisation.

And with talents like those "wings," Etjole may just have a chance against Hymneth the Possessed after all.

* * *

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Three years ago, I reviewed L.E. Modesitt's *Of Tangible Ghosts*, praising the idea that ghosts could be real, appearing after traumatic deaths, lingering, and spooking folks enough to make war difficult. As a consequence, history has taken a different course. The Dutch remain a strong presence in North America, from New Amsterdam up through New Bruges (New Hampshire). New France occupies Mexico. And the Hapsburgs are unifying Europe much as the Nazis tried to do in our own past.

As before, the protagonist of **The Ghost of the Revelator** is Johan Eschbach, once a secret agent and government minister, now a professor of environmental economics and politics at a small New Bruges college. His wife, Lysette duBoise, is a refugee singer from France and a professor of music. As a singer, she is superlative, a diva without peer, but politics has kept her from the stage. Now, however, there are signs that that is changing: a lucrative invitation to perform in the Salt Palace of Great Salt Lake City, capital of the nation of Deseret, followed by an invitation to sing at an awards dinner in Washington, capital of Columbia.

Yet something else is going on as well. Johan is receiving clippings in the mail, apparently from his one-time masters in the secret agent corps. They mention such things as new environmental technologies, synthetic fuel plants, international maneuverings over Arabian oil, and schismatic political tensions among the Mormons. Much is at stake, even if the details are murky, and someone is prepared to kill: There are several attempts on his and Lysette's lives.

Fortunately, Johan is a man of action, knows the secret of how to destroy ghosts *and* create them, and has access to the obligatory spy-tale gadget master who can whip up disguised weaponry on fairly short notice. He and Lysette thus arrive in Deseret well equipped for trouble, and if there seem few signs at first—Lysette's concerts are a stunning success—Modesitt is careful to point out the oversized ventilation grill in her dressing room. Lysette's eventual kidnapping is thus little surprise.

Why kidnap a singer, even a great one? The answer has a lot to do with what Johan knows and with the book's title, but I won't say more than that the kidnappers have neglected to take into account Johan's skills and cleverness. All ends well, with signs of improvement in both the political and environmental situations.

Last time, I admired Modesitt's version of ghosts but thought it difficult to swallow enough to believe. The ghosts are less prominent here—though they and the related technology do play crucial parts—and I found it easier to suspend disbelief in this tale, to concentrate on spies, politics, and the intricacies of Modesitt's alternate history, even to enjoy it more in important ways.

May you also.

Russell Like's **After the Blue** is a satiric poke at the broad array of easy targets that make up modern Western civilization—air pollution, traffic jams, cubicle offices, door-to-door salesmen, and the TV version of family life. There is nothing terribly insightful here unless one has never seen such satire before, which surely means the tale is best suited for younger readers.

The basic idea is thus: Not too long from now, bright yellow, four-armed space aliens with red potato noses, the Gruumsbaggians, stumble upon Earth, land, say hello to our world's assorted leaders, and depart. Shortly thereafter, a mysterious plague turns almost everyone into bright blue corpses (hence the title). Full of remorse, the Gruumsbaggians gather up as many survivors as they can, take them home, and start breeding and raising replacements. Meanwhile, the survivors they missed are gathering in Jamesburg, New Jer-

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sey, constructing a very sane replacement for Western civilization, and wondering if the Gruumsbaggians didn't really do them a favor by destroying the old version.

And now the Gruumsbaggians are back, hell-bent on putting things back the way they were, based on a handful of salvaged books, tabloids, videotapes, and misguided statistics. The results are loopy enough to warrant the comparison with Douglas Adams's *Hitchhiker's Guide to the Galaxy* series, and the conclusion invites both a sequel and the thought that Like is quite deliberately playing games with popular SF themes.

Unfortunately, Like's tale is pretty hard to swallow, largely because it seems very unlikely that the informational remains of civilization would be so fragmentary and distorted. For instance, the Gruumsbaggians think air pollution was a desirable and essential feature of the status quo and labor mightily to restore it, even as they clear-cut the regrown forests and pave over Jamesburg's farmland. Yet magazines, books, and videotapes are loaded with accounts of our attempts to redress these evils.

Of course, if Like had tried to recognize that component of the media discourse, he would have had to make his Gruumsbaggians seem more sensible, which would have sapped the vigor of his satire and robbed him of his point. So grant him his selective vision for the sake of the story and try the book on anyone who ever loved the *Hitchhiker's Guide*.

Bruce Boston's latest collection of short pieces, **Dark Tales & Light**, serves up an ample dose of surreal, sardonic wry humor, drawn mostly from the small press magazines. You will surely enjoy "Pest Control," in which tiny flying saucers become the futuristic equivalent of Japanese beetles: you spray for them, and if you have an inquiring mind, you try to communicate with them—with astonishing results. For a Boston look at sexism, see "Pulp Woman Gets Her Man," whose title character has a staunch sidekick named Dildo stuck in the fun house at the County Pig Fair.

There's more too, all as deft and quirky as I've called Boston's work before. You'll enjoy.

Andrew Weiner is a quirky Canadian whose work has a very European feel. That is, he is less direct than US readers may be accustomed to, more surreal even than our surrealists, perhaps even snide in his sniping at human foibles and follies. If you wish to see what I mean, pick up a copy of his collection, **This Is the Year Zero**, in which you will find "A New Man," which offers a scheme for improving husbands, and eleven more gems drawn from the last fifteen years. Two more are new here and well worth your attention: "The Disappearance Artist" concerns a fellow who has acquired a knack for evading the perplexities of life, leaving only images behind. "The New Frequencies" concerns mind-control buried in a SETI signal.

Fred Lerner describes his **The Story of Libraries: From the Invention of Writing to the Computer Age** as "an informal history of one of the most enduring of human institutions," from Sumer's clay tablets to the scrolls of Alexandria to the ancient and modern libraries of Europe, Asia, and the Islamic world (pre-Columbian America is not covered for lack of reliable evidence of anything resembling libraries). But it is more than a history of libraries alone, for Fred pays a great deal of attention to historical context, to the functions of libraries in their societies, and his book is thus a history of civilization with a rather different emphasis from the usual. It is thus well worth your attention.

Something that emerges from the account is how perishable are books. Libraries are temporary institutions; they typically fall victim to fire and war and

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hysteria; their contents are purged in the names of ideology, religion, and censorship. Those books that survive do so by sheer good fortune or—no surprise here!—by popularity (the more copies exist, the harder it is to destroy them all). Thus when Fred dismisses digital publication and computer nets (the Internet) in favor of paper and microfilm (marvelously simple and durable, especially when compared to the challenges of translating computer files to new formats and media), he seems to me to miss an important point: One great advantage to the "World Wide Library" (if I may call it that) is the profusion of copies—including printouts—which may well make it forevermore impossible to expunge a book in toto.

He recognizes that computers and Internet are of growing importance for access to information, and that someone will still have to catalog and index and screen. Much of this is already falling to search engines such as Altavista and Yahoo and Infoseek, but recent research has shown how incomplete a 'Net search can be. There is much room for improvement, and as he noted in a letter, "I believe that the more successful of Web search engines are those whose producers have librarians on their staff. In the near term, at least, I expect to see meta-sites produced and maintained by librarians play an increasingly important role in giving people access to the information contained on the Web." For the long term, he wrote me, he will be sure to let Ye Editor of this magazine know whatever he thinks up—and Ye Editor will then surely print Fred's piece.

Clifford A. Pickover likes to combine science fiction scenarios with serious explication of serious mathematics, with the added charm of appendices full of computer programs you too can play with. I reviewed *Chaos in Wonderland* in April 1995 and *The Loom of God* in December 1997. Now we have **Time: A Traveler's Guide** in the same mold. It outlines the large amount of work post-Einsteinian physicists have done in the search for ways to move in time, from wormholes and tachyons to cosmic strings and more. The scenario centers on Chopin, with the goal of the study of time being a trip back to meet the maestro, and if it's a bit coy, that's okay. This time out, Pickover seems more deft and less annoying, despite the presence of a number of dreadful typos. (Stephen Hawking did *not* formulate a "Chronology Projection Conjecture" [p. 171]).

For *Analog* readers, the greatest drawback may be that most of his time travel material has been covered here in science fact articles. For others, Pickover presents a smooth and tasty review of some of the more outré aspects of relativity. ■

As peace is the end of war, so to be idle is the ultimate purpose of the busy.

— Samuel Johnson

There is no conceivable human action which custom has not at one time justified and at another condemned.

— Joseph Wood Krutch

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BRASS TACKS

Dear Mr. Schmidt:

I am a long-term *Analog* reader and subscriber, but I have never written to you or participated in the annual rating derby you hold before.

However, I wanted to express my compliments on the outstanding editorial quality of the July/August double edition of *Analog*. Except for the *Children Star* serial (which I just haven't gotten into) I read every article word for word. Most were great. "Slow Drowning" by Daniel Hatch, though, was brilliant and haunting. It's the best story I've read in your journal or others in years. I will be looking for more product from this excellent author.

Keep up the good work!

LOUIS H. KNAPP

Dear Stan:

Joan Slonczewski has done it: I actually could suspend disbelief in sapient *microbes*! And I'm a bacteriologist for the Ashland Water Plant. I had expected the "hidden masters" to turn out to be a planetary intelligence (the little girl's name "Gaea" suggested that—but then maybe she was the "world" to the microzooids).

STUART-MORGAN VANCE
700 Highland Avenue
Ashland, KY 411042-5244

Editor:

Thank you for presenting *The Children Star*, a story which combines all the classical elements of good science fiction: advanced science, a good conflict, and believable characters. I'm not a biologist so I can't comment on the triplex DNA idea, but I found it interesting and the hypothesized consequences believable. It brought to life the question—Not only will we recognise other life forms as intelligent, but will they recognize us? The characters, whether human or otherwise, had approaches to the conflict (the impending destruction of the planet and their own personal plights) which reflected their personalities. The interplay of power in the highest reaches of the government added to the interest. The differentiation of the intelligent microbial life colonies as they were separated by generations (days) from others of their kind led to interesting thoughts. Will they ask their human hosts/planets/gods to intervene for them against the other colonies? I'm looking forward to a follow-up, possibly from the viewpoint of the microbial life trying to understand these strange new worlds they are now inhabiting.

BERNIE CARLTON

Dr. Schmidt:

Just a note to thank you for a fine July-August issue. I finished it this morning and was pleased with what I read. For the most part.

In the short story "In Space, No One Can Hear," Michael Burstein made some rather startling literary (for want of a better word) errors. For example, in the third paragraph of his story he says, "Another handhold, another foothold, and Jake pulled his slender frame another few meters." Um. Mr. Jake must have one humongous reach to be able to move his body *meters* (a meter is about

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40 inches; two meters is around 80 inches—six feet and then some) in just one handhold-foothold pair. Perhaps decimeters would have been a better word. Unless Jake is a giant, the best he could hope for in a single stride up a ladder is about half a meter. Maybe.

Other than such mild annoyances, his story was somewhat entertaining. I gave it a B+ for plot and an A++ for political correctness.

Regrettably, the other issue is with your editorial. Being a computer programmer, and something of a thinker (however poorly trained) in my own right, I read your essay with dismay. Sir, it is fine to research the apes and learn that they have untapped potential, but to decide that we may start dancing on the lawn and shouting "Just like us! Just like us!" on the basis of research that cost hundreds of thousands or perhaps millions of dollars, and which isolates these animals in pristine, controlled conditions, removing the need to struggle for everyday existence, forcing them to concentrate on behaviors that their trainers deem important and then decide on the basis of the resulting data that they are worthy of being fit into the same category where resides Homo Sapiens is an extremely long stretch. Just because apes can learn under stringently controlled conditions to communicate a few hundred words to humans is not enough in my books to admit them to the club of sapients. As a matter of fact, I suggest a further experiment, if the animal trainers have it in their hearts. Turn the learned beasts back into the wild. If they can still survive in the wilderness, I hypothesize that in a few years two things will be observed: The gorillas will have forgotten how to *talk*, and they will *not* have passed on the behavior to their peers.

As for the naturalists such as Jane Goodall (whom I greatly admire), who showed us that chimps have personality, she has yet to report on cathedral-making or poetry composition among chimpanzee populations, and no matter how you belittle such activities, no species that does not engage in behavior of a like kind can ever be called anything more than instinct machines, or animals. There are *birds* that use such tools as twigs to stab grubs from between rocks, or who can sense that there is a power outside themselves called gravity, and can be used to crack open hard clamshells. My beloved Labrador Retriever knows how to manipulate objects to get what he wants. Yet I will never concede that any of them are toolmakers. Just because our furry friends can use twigs to pry ants away from their nests, or leaves as makeshift sponges does not prove that they can abstract truth from their surroundings. Or that they even know or think of such concepts as truth.

You continued your discussion by roaming into the realm of future self-aware computers. You cited Dr. Hofstadter's contest where programmers were supposed to write a program that could compose music indistinguishable from Bach. (I would love to get a look at that code!)

I do not know whether computers will ever be self-aware. I admit it; my prejudices weigh in against the possibility. I do know that such situations as you cited (chess-playing computers, composition-creating CPUs) are very poor examples of thinking programs. These programs are unidimensional. Specialized. Heuristic. Not at all like humans who are generalized and in many ways, intuitive. And further, I will be very hard pressed to accept the fact that these programs *appreciated* what they were doing. For a long time, that will indeed separate us from computers. Humans can, among other human traits, appreciate, admire, generalize, intuit, abstract. Until computers can (and I will grudgingly admit that they may, some day), they will have earned no right to the sapients only club, of which, right now, as far as we know, re-

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gardless of how we might otherwise wish, humans are the only members.

Please keep up the good work and continue to stimulate our thinking with your fine essays.

JOHN DARNELL
pedantic@sprintmail.com

Please remember that "In Space, No One Can Hear" took place under weightless conditions, so Jake was not pulling himself up, but simply propelling himself along.

And in the editorial, I neither said "Just like us!" nor belittled such activities as cathedral-making or poetry composition. I did say that the differences between us and "lower" animals may be more quantitative than qualitative.

And please note that relatively few humans build cathedrals or poems—and the few who do couldn't without building on the accomplishments of lots and lots of ancestors.

Dear Dr. Schmidt,

Did the programmer feed the computer Bach's music? If so, it is imitating Bach. Try giving a computer all the musical information and theory that Beethoven had when he began his career, plus information on Beethoven's character and personality, religion, politics, world view etc.—and see if the computer can create music that makes the steps from Mozart and Haydn that Beethoven's does. I don't mean it must be the same as Beethoven's, just that it should make those steps in some way that produces very good, if not great music.

Or how about giving a computer all the literary, historical, religious, philosophical, political knowledge that Shakespeare possessed. Give it a personality that tends to the expressive. Give it the Elizabethan world view. But of course no Shakespeare or Marlowe or other contemporary and see what happens when you tell it to write a play or a sonnet. This, to me, would be a true test. Humans and animals, and maybe machines, may indeed have much more in common than many of us would like to think, but can they create in this way?

PATRICIA ANNE BUARD
565 Forest Rd.
Wayne, PA 19087
pbuard@snip.net

Like many readers who reacted in the way I described, you're raising the hurdles again! And the chances are quite good that sufficiently determined computer engineers (aided by computers!) can improve them to the point where they clear the hurdles, wherever you put them.

Dear Stan:

Your editorials, in general, have been thought-provoking and well laid-out. As I was reading "King of the Hill" I could appreciate each of your points and examples. Upon finishing, however, it struck me that I was not persuaded by them (though I agreed with your conclusion). So I deconstructed, and here are my provoked thoughts:

On language: An essential part of communication is mimicry—it's not only how we learn, but how we continue to communicate with and identify one another. Music is mimicry, too. So is art. You might have pointed out the speciousness of an argument that denigrated the benobos' "mere mimicry."

On computers: Here is a classic case of worshipping the created rather than the creator. The computer did not compose the music. Neither did the program. The programmer composed the music through his program just as the musicologist composed his piece through staff paper and pen. Let's stick with GIGO (genius in, genius out) and not build fancy idols out of fancy tools.

On exploitation: Though I agree with you that exploitation is more comfortable when the exploiter can view her-

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self as superior, inferiority to and equality with the victims have not presented barriers. Humanity's history of slavery, war, and oppression underscores my point. We carved out our niche with our brains and dexterous hands, and we continue to carve away.

On self-esteem: Once upon a time we earned what was called self-respect. But apparently the educators of today have thrown up their hands and told each other, "This new batch of kids is too stupid and too inept to earn self-respect. We'll tell them to feel good about themselves no matter what they're really like. We'll call it 'self-esteem'."

Your final paragraph is an excellent call to true humility. I have only one provoked thought on this: you enjoin that only a very few "can enjoy that luxury." Let us rather say that we all "can" right now, so let us "choose to" right now, as well. As to other species, I'd say people, alone, struggle with humility. Golly, maybe that makes us different!

JOANNE HAGEMEYER
Severna Park, MD

Interesting comments, but I can't agree that "The programmer composed the music." The computer (guided by the program) generated and selected the musical elements to constitute a new structure that was recognizable as belonging to a certain style. It's true that the programmer enabled it to do that, but he himself did not make the choices that are composition. If I buy your argument, I must also buy the argument that Beethoven didn't really compose his symphonies. God, or evolution, did. (I suppose there are some who do buy that, but I'm not one of them.)

Editor:
A Sonnet on Why Fintushel's Verse Is Not

His verse is witty, but it's not a sonnet.
A sonnet's lines have five iambic feet,
I'll bet these fourteen metered line
upon it,
While his have only four and miss a beat.

On top of that, he's got the rhyme
scheme wrong,
It's not Pentarchian *(sic)* or Shakespeare's verse,
But seven lazy couplets like a song
Sung by a country-western star or
worse.

There is a modern trend to fiddle form
To suit a poet's inabilities
To whittle words to fit the defined
norm.
I have old-fashioned sensibilities;

Conform-to-form is one bee in my
bonnet.
I like his poem, but it is not a sonnet.

KAREN TELLEFSEN
New Jersey
kat@interactive.net

Well, yes and no. It's true that it's neither Petrarchan nor Shakespearean, but if you read (for example) the Encyclopedia Brittanica*'s article on "sonnet," you will find that the definition is considerably broader than that and allows for other variations on the form, several of which have already been generally recognized.*

Sirs:

I read with great interest the article by Geoffrey Landis, in your July/August issue, about his experiences with the Mars Pathfinder missions.

Back in 1978 NASA published a book regarding its Viking missions, entitled *The Martain Landings*, by the Viking Lander Imaging Team, NASA SP-425.

The book was fascinating in and of itself, but was made doubly so by its inclusion of stereoscopic pictures taken by the Landers, and a stereo viewer through which you could see the landscape depicted in 3 dimensions.

Anyway, I got to wondering:

•Has NASA, or anyone else you're

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aware of, published a similar book about the Pathfinder mission?

•Are there available anywhere 3-D color pictures of the type described by Mr. Landis which surrounded the Lander Team's work area?

•Perhaps more impressively, is there avilable anywhere a CD which you can insert into your PC and view stereoscopically, in the same way as we saw Sojourner's "driver" doing on television, images transmitted from Mars back to Earth?

A while back (perhaps quite a while) there was an editorial in your magazine about viewing the results of NASA's expeditions as entertainment as well as scientific/engineering achievements. While "entertainment" is perhaps too flighty a word for what I'm inquiring about, something like the above would certainly help make the results of the expeditions more readily available to the taxpaying public, educational institutions, and so forth.

Available, for viewing and reviewing, long after the excitement has died down and the news organizations have returned to their daily litany of wars, disasters, and the related negatives we're constantly being inundated with.

And, who knows, it just might help ensure that, in the future, such missions' funding isn't cut with so little fanfare or forethought.

(Sorry about the soapbox.)

Anyway: Is there anything like what I've described available anywhere?

JAMES L. HALL

Dear *Analog*,

The 3-D images of Mars produced by Pathfinder are available in "anaglyph" format on the world-wide web at the site http://mars.jpl.nasa.gov/mpf/anaglyph-arc.html.

In answer to the question of whether there will be a book on Pathfinder similar to the Viking books, there is a book just published by the National Geographic Society book: *Mars: Uncovering the Secrets of the Red Planet*, with text by project scientist Matt Golombek. It should be in bookstores by now. There is also an article about Pathfinder, with 3-D pictures, in the August 1998 *National Geographic Magazine*.

GEOFFREY A. LANDIS
scientist and part-time SF writer
http://www.sff.net/people/Geoffrey.Landis/ ■

(Biolog continued from p. 89)

being Ray Bradbury's The Illustrated Man. Liking SF did not keep Shane from delving widely into other literatures.

Writing began in his teens. He even completed two novels, one of which may yet be published after a more mature rewrite. He hit a treasure trove of old *Analog*s in an attic, which served both to excite his imagination and to act as exemplars of short fiction. He then stepped up writing and submitting, taking just over two years to land a spot in the February 1998 *Analog*.

Shane has yet to finish working out his approach to story telling. He tends to start with a collection of ideas that he sorts into a story. Inspiration comes from current events, science news, or nearly anything else. Shane considers SF the most vital genre in writing, with the greatest scope for creativity. Yet he finds much of the world is sliding backward into superstition and spiritualism, and the Moon left abandoned. The logic of hard science coupled with visions of a world made grander by the intelligence of man is science fiction's solution to preventing the decay of Western, technical civilization. ■

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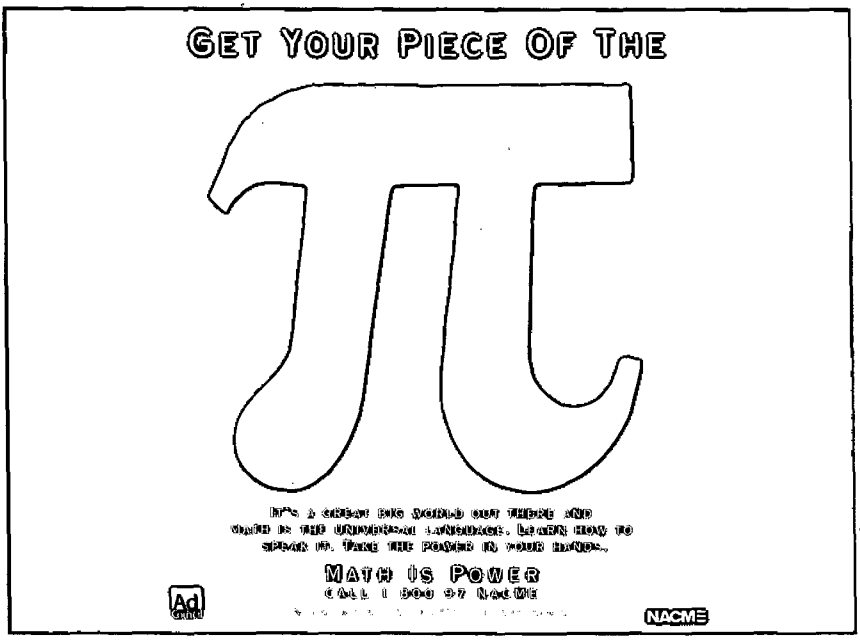
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UPCOMING EVENTS Anthony Lewis

15–17 January 1999
ARISIA '99 (Boston-area speculative media conference) at Boston, MA. Guest of Honor—Rober McBride Allen; Fan Guests of Honor—Teresa and Patrick Nielsen Hayden. Registration—$30 until 30 November 1998. Info—Arisia, Inc., 1 Kendall Square, Suite 322, Cambridge, MA 02139. e-mail—info@arisia.org; URL—www.arisia.org/

22–24 January 1999
POTLATCH 8 (Oregon literary SF conference) at Doubletree Inn, Eugene, OR. Registration—$30 until 31 December 1998, $35 at the door. Info—Potlatch 1999, 355 Howard Street, Eugene, OR 97404. e-mail—potlatch@efn.org; URL—www.efn.org/~potlatch/

12–14 February 1999
BOSKONE 36 (New England SF conference) at Sheraton Framingham, Framingham, MA. Guest of Honor—Connie Willis; Official Artist—Stephen Youll; Special Guests—Teddy Harvia and Diana Thayer. Registration—$35 until 30 July 1998. Info—Boskone 36, Box 809, Framingham, MA 01701-0809. (617) 625-2311. e-mail—boskone@nesfa.org; URL—www.nesfa.org/boskone/

2–6 September 1999
AUSSIECON THREE (57th World Science Fiction Convention) at World Congress Centre, Melbourne, Australia. Guests of Honour—George Turner (in memoriam), Gregory Benford, Bruce Gillespie. Registration—$155 (A$200); supporting $35 (A$45).[These are the latest posted rates as of the time this column went to press. Rates will go up mid-August 1998 and then again 1 January 1999.] This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info—Aussiecon Three, GPO Box 1212K, Melbourne VIC 3001, Australia. US Agent—PO Box 266, Prospect Heights, IL 60070-0266. URL—www.aussiecon3.worldcon.org

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4–7 November 1999
WORLD FANTASY CONVENTION/VOYAGES at Rhode Island Convention Center, Westin Hotel, Biltmore Hotel, Providence, RI. Guests of Honor—to be announced. Registration—$85 until 30 November 1998, then more (limited to 850); $35 supporting (payable to MCFI). Info—World Fantasy Convention, c/o MCFI, Box 1010, Framingham, MA 01701-1010; fax—(617) 776-3243. e-mail—wfc@mcfi.org; URL—www.world.std.com/~sbarsky/wfc99.html

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Convention runners: If your convention has a telephone, FAX, e-mail, or Web page URL, please let us know so that we can publish this information.

Convention attenders: When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an IRC if the convention is in a different country. ■

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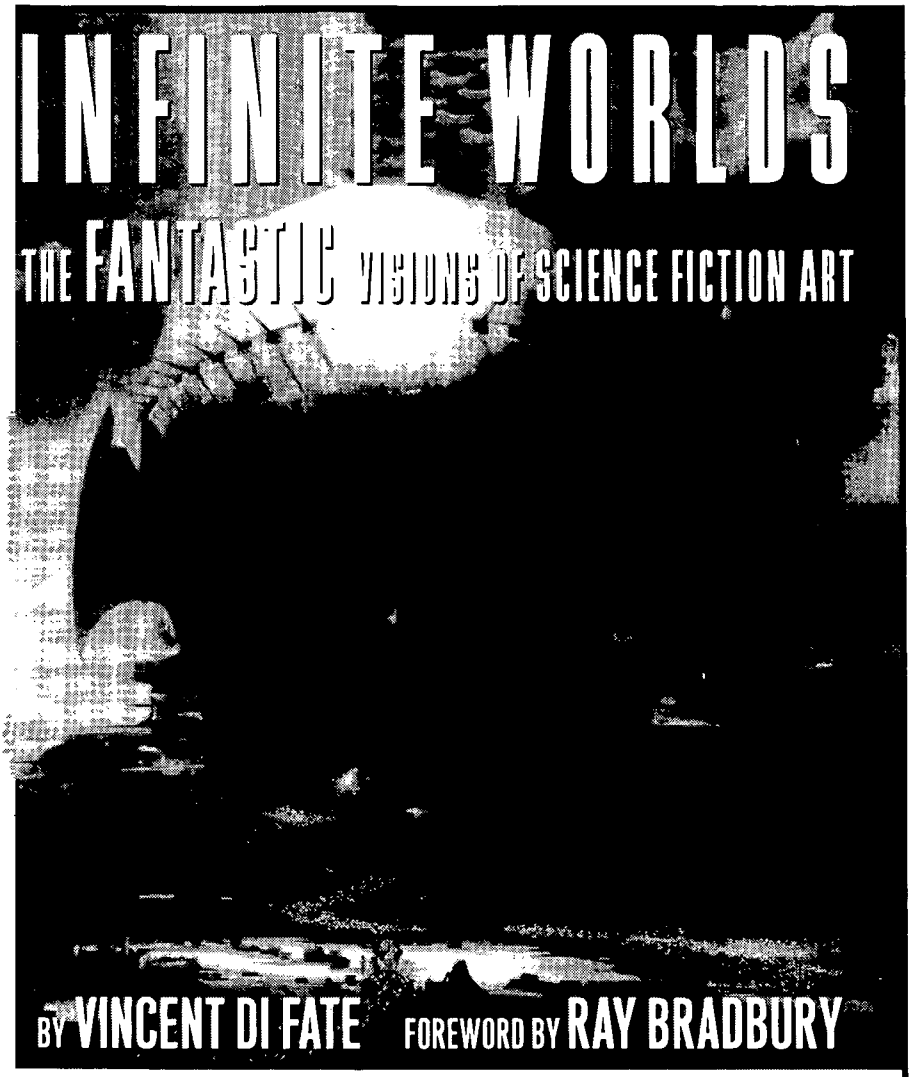

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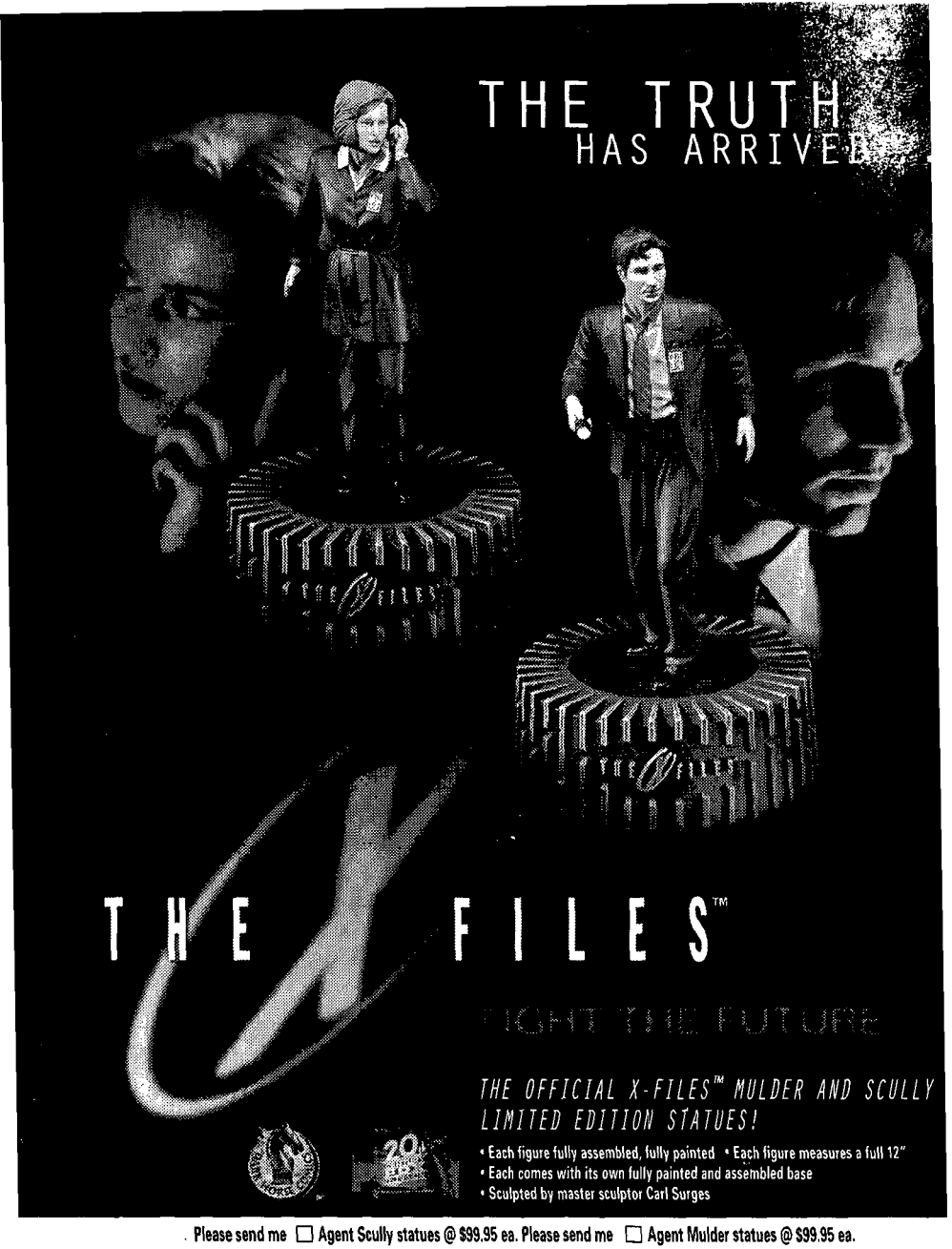

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